SCIENTIFIC AMERICAN

A Weekly Review of Progress in

INDUSTRY · SCIENCE · INVENTION · MECHANICS

IN THIS ISSUE:

CLEANING CHICAGO'S STREETS WITH THE NEW SNOW LOADER AND MOTOR TRUCK.—[See page 153]

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Chart of Recommendations
for AUTOMOBILES
(Abbreviated Edition)

GARGOYLE

Mobiloils

A grade for each type of motor

How to Read the Chart

THE Correct Grades of Gargoyle Mobiloils for engine lubrication are specified in the Chart below.

A means Gargoyle Mobiloil "A"
B means Gargoyle Mobiloil "B"
E means Gargoyle Mobiloil "E"
Arc means Gargoyle Mobiloil Arctic

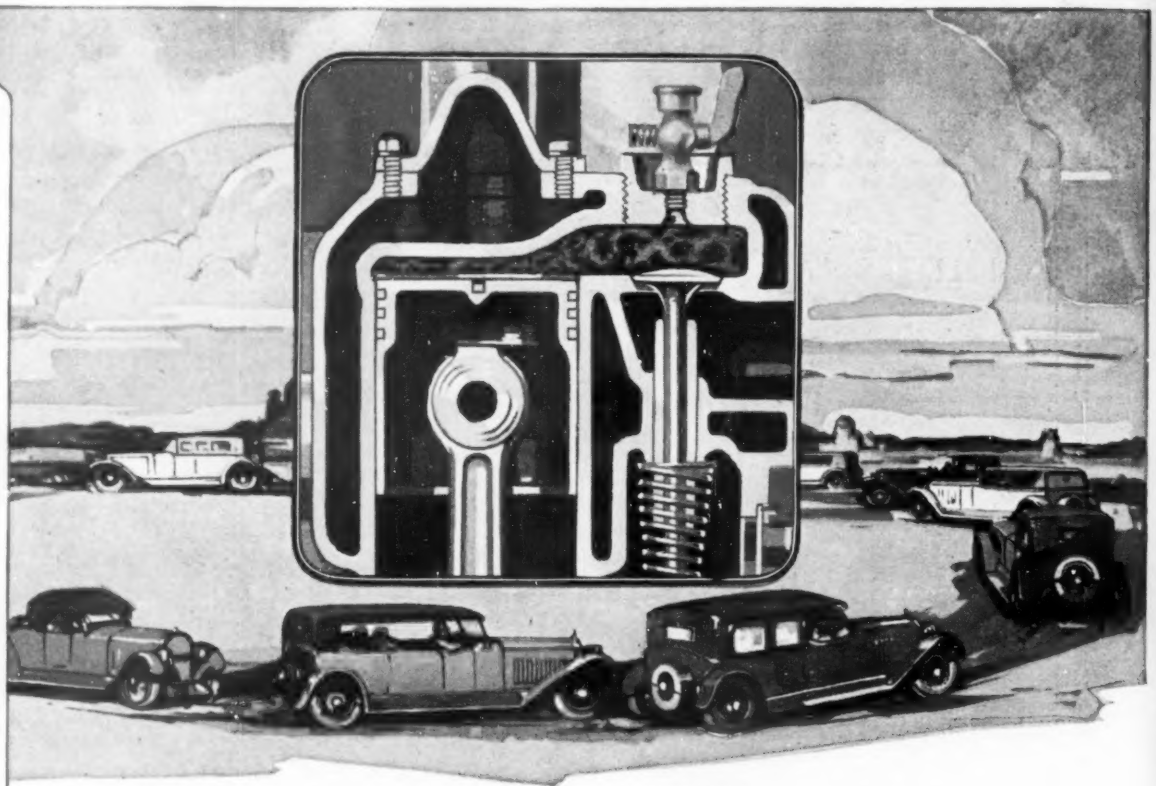
These recommendations cover all models of both passenger and commercial vehicles unless otherwise specified.

Where different grades of Gargoyle Mobiloils are recommended for summer and winter use, the winter recommendation should be followed during the entire period when freezing temperatures may be experienced.

This Chart is compiled by the Vacuum Oil Company's Board of Automotive Engineers, and constitutes a scientific guide to Correct Automobile Lubrication.

If your car is not listed in this partial chart, consult the Chart of Recommendations at your dealer's, or send for booklet, "Correct Lubrication," which lists the Correct Grades for *all* cars.

NAMES OF AUTOMOBILES AND MOTOR TRUCKS	1920 Summer	1920 Winter	1919 Summer	1919 Winter	1918 Summer	1918 Winter	1917 Summer	1917 Winter	1916 Summer	1916 Winter
Allen	A	Arc.	A	Arc.	A	Arc.	A	Arc.	A	Arc.
Anderson			Arc.	Arc.	Arc.	Arc.	Arc.	Arc.	Arc.	Arc.
Armleder (1 ton)	A	A								
" All Other Models	Arc.	Arc.	Arc.	Arc.	Arc.	Arc.	Arc.	Arc.	Arc.	Arc.
Auburn (4 cylinder & 6-38)							A	Arc.	A	Arc.
" (6 cylinder)	Arc.	Arc.	Arc.	Arc.	Arc.	Arc.	Arc.	Arc.	Arc.	Arc.
" (6-39 B) (Teetor-H Eng.)					A	Arc.				
Buick	Arc.	Arc.	Arc.	Arc.	Arc.	Arc.	Arc.	Arc.	Arc.	Arc.
Cadillac	A	A	A	A	A	A	A	A	A	A
Chalmers (6-48)									Arc.	Arc.
" (6-40)									A	Arc.
" All Other Models	A	A	A	A	A	A	A	A	A	A
Chandler Six	Arc.	Arc.	Arc.	Arc.	Arc.	Arc.	Arc.	Arc.	Arc.	Arc.
Chevrolet (8 cylinder)			A	A	A	A	A	A		
" (F. A.)			A	Arc.	A	Arc.				
" (F. B. & 1 ton)	A	Arc.								
" All Other Models	Arc.	Arc.	Arc.	Arc.	Arc.	Arc.	Arc.	Arc.	Arc.	Arc.
Cleveland	A	Arc.								
Clydesdale (120 B)	A	A	A	A						
" All Other Models	Arc.	Arc.	Arc.	Arc.	Arc.	Arc.	Arc.	Arc.	Arc.	Arc.
Cole (6 cylinder)									Arc.	Arc.
" (8 cylinder)	A	A	A	A	A	A	A	A	A	A
Cunningham	A	A	A	A	A	A	A	A	A	A
Dodge Brothers	A	Arc.	A	Arc.	A	Arc.	A	Arc.	A	Arc.
Elgin	A	Arc.			A	Arc.	A	Arc.	A	Arc.
Essex	A	Arc.	A	Arc.						
Federal (Model S-X)					A	A	A	A		
" (Special)					Arc.	Arc.				
" All Other Models	Arc.	Arc.	Arc.	Arc.	A	A	Arc.	Arc.	Arc.	Arc.
Ford	E	E	E	E	E	E	E	E	E	E
Franklin	A	A	A	A	A	A	A	A	A	A
Garford (1½, 5 & 6 tons)	A	A	A	A	A	A	A	A	A	A
" All Other Models	A	Arc.	A	Arc.	A	Arc.	A	Arc.	A	Arc.
Grant (6 cylinder)	A	Arc.	A	Arc.	A	Arc.	A	Arc.	A	Arc.
" (Com.) (Model 12)			A	Arc.						
" (") All Other Models	Arc.	Arc.	Arc.	Arc.						
Haynes (6 cylinder)	A	Arc.	A	Arc.	A	Arc.	A	Arc.	A	Arc.
" (12 cylinder)	A	A	A	A	A	A	A	A	A	A
Holmes	B	A								
Hudson Super Six	A	Arc.	A	Arc.	A	Arc.	A	Arc.	A	A
" All Other Models									Arc.	Arc.
Hupmobile	A	Arc.	A	Arc.	A	Arc.	A	Arc.	A	Arc.
Jordan	Arc.	Arc.	Arc.	Arc.	Arc.	Arc.	Arc.	Arc.		
Jumbo	A	A	A	A	A	A				
King (8 cylinder)	A	A	A	A	A	A	A	A	A	A
Kissel Kar (Model 48)									A	A
" " (12 cylinder)					A	A	A	A		
" " All Other Models	A	Arc.	A	Arc.	A	Arc.	A	Arc.	A	Arc.
Kline Kar	Arc.	Arc.	Arc.	Arc.	Arc.	Arc.	Arc.	Arc.	Arc.	Arc.
Lexington	Arc.	Arc.	Arc.	Arc.	Arc.	Arc.	Arc.	Arc.	Arc.	Arc.
Liberty	A	A	Arc.	Arc.	Arc.	Arc.	Arc.	Arc.		
Locomobile	A	E	A	E	A	E	E	E	E	E
Mack (Models AB & AC)	A	Arc.	A	A	A	A	A	A	A	A
" All Other Models									A	E
Maibohm	A	Arc.	A	Arc.	A	Arc.	A	Arc.		
Marmon	A	A	A	A	A	A	A	A	A	A
Maxwell	Arc.	Arc.	Arc.	Arc.	Arc.	Arc.	Arc.	Arc.	Arc.	Arc.
Mercer	A	A	A	A	A	A	A	A	A	A
Mitchell (6 cylinder)	A	Arc.	A	Arc.	A	Arc.	A	Arc.	A	Arc.
" (8 cylinder)									A	A
Moline-Knight			B	A	B	A	A	A	A	A
Moon	Arc.	Arc.	Arc.	Arc.	Arc.	Arc.	Arc.	Arc.	Arc.	Arc.
Nash (Quad)	A	A	A	A	A	A				
" (Model 671)					A	A				
" All Other Models	A	Arc.	A	Arc.	A	Arc.				
National (6 cylinder)	A	A	Arc.	Arc.	Arc.	Arc.	Arc.	Arc.	A	Arc.
" (12 cylinder)			A	A	A	A	A	A	A	A
Nelson	A	A	A	A	A	A	A	A		
Oakland (8 cylinder)									A	A
" All Other Models	A	A	A	A	A	A	Arc.	Arc.	Arc.	Arc.
Oldsmobile (4 cylinder)	A	Arc.	A	Arc.					Arc.	Arc.
" (6 cylinder)	A	A	A	A	A	A	Arc.	Arc.		
" (8 cylinder)	A	A	A	A	A	A	A	A	A	A
Overland	A	Arc.	Arc.	Arc.	Arc.	Arc.	Arc.	Arc.	Arc.	Arc.
Owen Magnetic (Model M-25)					Arc.	Arc.	Arc.	Arc.		
" " All Other Models	A	A	A	A	A	Arc.	A	Arc.	A	Arc.
Packard	A	A	A	A	A	A	A	A	A	A
Paige (6 cylinder)	A	Arc.	A	Arc.	A	Arc.	A	Arc.	A	Arc.
" (Cont. Eng.)	Arc.	Arc.	Arc.	Arc.	Arc.	Arc.	Arc.	Arc.	Arc.	Arc.
" All Other Models	A	A								
Peerless (8 cylinder)	A	A	A	A	A	A	A	A	A	A
" All Other Models					Arc.	Arc.	Arc.	Arc.	Arc.	Arc.
Pierce Arrow	A	A	A	A	A	A	A	A	A	A
" " (Com.) (3 ton)	A	A	A	A	Arc.	Arc.	Arc.	Arc.	Arc.	Arc.
" " " All Other Models	Arc.	Arc.	Arc.	Arc.	Arc.	Arc.	Arc.	Arc.	Arc.	Arc.
Premier	A	A	A	A	A	A	A	A	A	Arc.
R. & V. Knight	B	A								
Rainier (1½ ton)	Arc.	Arc.	Arc.	Arc.						
" All Other Models	Arc.	Arc.	A	Arc.	A	Arc.	A	Arc.		
Rex	A	Arc.	A	Arc.	A	Arc.	A	Arc.	A	Arc.
Riker	A	E	A	E	A	E	E	E		
Rock Falls	A	Arc.	A	Arc.						
Saxon			E	E	E	E	E	E	E	E
Scripps-Booth (4 cylinder)					Arc.	Arc.	A	Arc.	A	Arc.
" " (6 & 8 cylinder)	A	A	A	A	A	A	A	A	A	A
Standard Six									A	Arc.
" (8 cylinder)	A	A	A	A	A	A	A	A	A	A
Stearns-Knight	B	A	B	A	B	A	A	A	B	A
Stewart (Buffalo)									Arc.	Arc.
" " (Com.) (¾ ton)	A	Arc.	A	Arc.	A	Arc.	A	Arc.	A	Arc.
" " (") (1 ton)	Arc.	Arc.	A	Arc.	A	Arc.	A	Arc.	A	Arc.
" " (") All Other Mod.	Arc.	Arc.	Arc.	Arc.	Arc.	Arc.	A	Arc.	A	Arc.
Studebaker	A	Arc.	A	Arc.	A	Arc.	A	Arc.	A	Arc.
Stutz	A	A	A	A	A	A	A	A	A	A
Templar	A	A	A	A	A	A				
Velie (Model 34)	A	Arc.								
" (6 cylinder)	Arc.	Arc.	Arc.	Arc.	Arc.	Arc.	Arc.	Arc.	Arc.	Arc.
" (Com.) (¾ ton)			A	Arc.	A	Arc.				
" (") All Other Models	Arc.	Arc.	Arc.	Arc.	Arc.	Arc.				
Ward La France	A	A	Arc.	Arc.						
Westcott	Arc.	Arc.	Arc.	Arc.	Arc.	Arc.	Arc.	Arc.	Arc.	Arc.
White (16 valve)			A	A	A	A	A	A		
" (3 ton)			A	A	Arc.	Arc.				
" All Other Models			Arc.	Arc.	Arc.	Arc.	Arc.	Arc.	Arc.	Arc.
Willys-Knight	B	A	B	A	B	A	A	A	B	A
Willys Six	A	Arc.	Arc.	Arc.	Arc.	Arc.	Arc.	Arc.		
Winton	Arc.	Arc.	Arc.	Arc.	Arc.	Arc.	Arc.	Arc.	Arc.	Arc.



Compression Mistakes

Expensive risks in using oil heavier than that specified in the Chart

THERE are motorists—you will find some everywhere—who think too much of compression. This leads to trouble.

To "rush hills" they want compression above everything else. Someone suggests a heavier oil. They try it. And sometimes a car will temporarily show better compression with heavier oil than with the grade specified in the Chart. But the driver pays the penalty later.

Then there is the user of a worn car, with worn pistons, piston rings and cylinder walls. He thinks that heavier oil will help fill the larger clearances caused by wear, so the change is sometimes made. Compression may improve but the motorist runs serious risks.

There are four leading reasons why "heavier oil" invites expensive risks:

1. The rate of wear on different makes and types of engines varies widely. Reasons: differences in designs used in parts; differences in construction; differences in manufacturing processes; differences in materials used; differences in the care which individual motorists give their cars.

2. Wear is not uniformly progressive in proportion to the mileage covered. All new engines must be broken in. Rubbing surfaces must be worn one to the other to produce smooth contact. During the "breaking in" period, wear is slight but rapid. Then, for a period, wear is gradual and dependent upon the degree to which the engine is correctly and efficiently lubricated and the care the engine is given. Finally, as power lessens, engine performance becomes erratic—and as noise develops the car requires overhauling and replacements before *any* oil can supply correct lubrication.

3. Piston clearances and piston ring fits do not alone determine the choice of the correct oil. Three other vital considerations are—operating temperatures, the designs of the lubricating systems (which are frequently unsuited to heavy oils) and the inability of some engines to use heavy oils without the quick production of carbon deposits.

4. The use of heavy oil will not necessarily insure greater oil mileage or freedom from "oil pumping." When piston rings become worn in their recesses in the piston, oil pumping increases, and low oil mileage and carbon deposit follows.

GARGOYLE MOBILOILS are specified in the Chart for *engine results*. Every engine factor is considered by the Vacuum Oil Company's engineers when they recommend the correct grade for *your* car. Badly worn cars need overhauling. Heavier oil may only multiply existing troubles.

The correct grade of Gargoyle Mobiloils specified in the Chart will lubricate correctly every friction point in your car.

Don't invite trouble by using "a heavier oil."

If your car is not listed on the partial Chart to the left send for our booklet "Correct Automobile Lubrication," which contains the complete Chart. Or consult the complete Chart at your dealer's. *Then use the oil specified.*

In writing, please address our nearest branch.

GARGOYLE

Mobiloils

A grade for each type of motor

Domestic Branches: New York, Boston, Philadelphia, Pittsburgh, Detroit, Chicago, Minneapolis, Indianapolis, Kansas City, Kan., Des Moines

VACUUM OIL COMPANY *Specialists in the manufacture of high-grade lubricants for every class of machinery. Obtainable everywhere in the world* NEW YORK, U.S.A.

SEVENTY-SEVENTH YEAR

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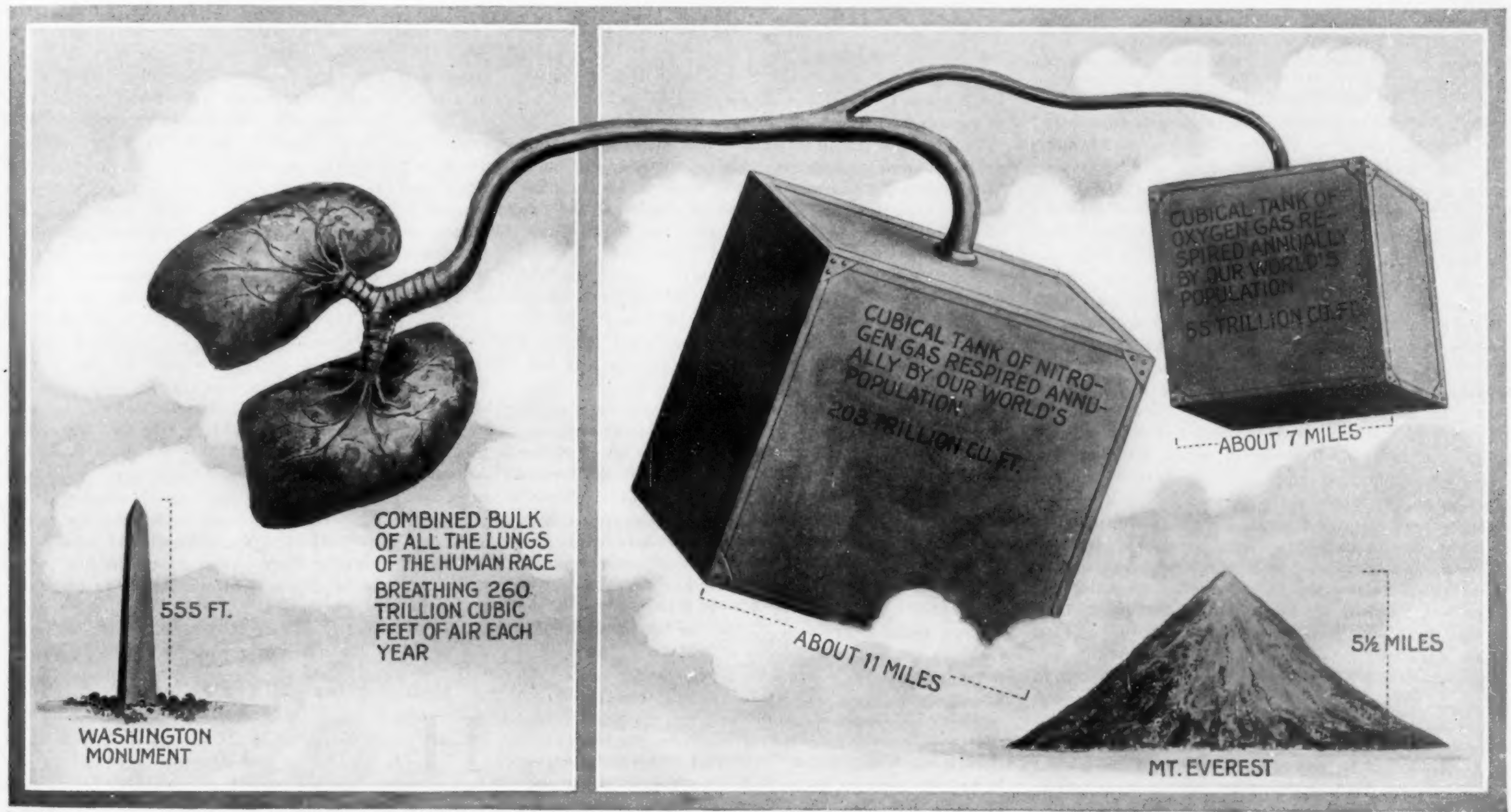

Combined bulk of all the lungs of the human race, breathing 260 trillion cubic feet of air each year

"The Breath of Life"

By Charles Nevers Holmes

SOME of us waste more breath than others of us. All of us waste more or less breath. and it seems a pity that such a loss should be going on all the time. Our "breath of life" consists of several gases, as well as a small amount of water vapor, and impurities. We all know that oxygen supports life and that nitrogen dilutes the energy of the oxygen we inhale. In pure air, we find about 78 per cent of nitrogen and about 21 per cent of oxygen, the remaining 1 per cent containing very small amounts of argon, carbon dioxide, hydrogen, and other gases. Our "breath of life" consists of a mixture of these several gases, each independent of the others, and is not formed like water of *united* gases, oxygen and hydrogen. As we are very well aware, air is not nearly so heavy as water, indeed, water weighs about 773 times as much as air. That is to say, if a cubic foot of water weighs 62½ pounds, a cubic foot of air would weigh only about 1 3/10 ounces.

We draw a breath of air through the nose, it enters our lungs and there purifies the blood which is returning to the left auricle of the heart after circulating through the body. We draw in this breath, the oxygen in it purifies our blood, and then we expel this breath, now impure with carbon dioxide. The action of our lungs, expanding or contracting, is peculiar, inasmuch as our lungs expand or contract according to the expansion or contraction of the surrounding chest cavity in which they are placed. That is, our lungs are merely elastic bags, with a tendency to expand, whereby they are filled with air, an inhalation, and when they are squeezed by our contracting chest, they part with some of their air, an exhalation. In ordinary breathing, the average adult inhales and exhales, at each respiration, about 30 cubic inches of air. This *tidal* air is, however, only a small portion of all the air in our lungs, the remaining ⅞ being stationary. That is to say, after we have exhaled 30 cubic inches of air, there is still left in our lungs more than 200 cubic inches, about ⅙ of a cubic foot.

However, the total amount of air respired by only one individual during a lifetime of threescore and ten years is enormous. It is easy to compute that amount. If we take for an *average* 28 cubic inches, since a human being does not respire as much in childhood, then one of us inhales and exhales within a minute—at the rate of 18 respirations—504 cubic inches of air; within an hour, 30,240 cubic inches; in a day, almost 726,000 cubic inches; in a year, almost 265,000,000 cubic inches; in threescore and ten years, about 18,543,000,000 cubic inches, approximately 10,730,000 cubic feet. In other words, if a cubic foot of air weighs about 1.294 ounces, then each one of us would inhale during a lifetime of 70 years approximately 435 tons of the "breath of life!" That is, about 6 1/5 tons per year. In other words, all the citizens of our 48 states respire annually 658,000,000 tons. Or, the whole population of the world, about 10½ billion tons of air. Therefore, the whole population of our world, in order to live, inhales yearly at least 2 1/5 billion tons of oxygen. Now, since our world's population inhales annually about 260 trillion cubic feet of air, it would inhale during the same time about 55 trillion cubic feet of oxygen gas. Accordingly, our world's annual respiration would fill full of air a tank which would be a mile square at its base and about 1,765 miles in height. And the world's yearly respiration of oxygen—the real "breath of life" —would approximate a similar tank about 370 miles in height.

Such is human breath—the "breath of life!" At every breath we exhale we begin to die, at every breath we inhale we begin to live. It is either respiration or expiration. Yet were the proportions of our "breath of life" to be changed a little—were it to contain more oxygen or less oxygen than it does—what a change would also take place in some of our bodily mechanisms! If we survived such a change, it would certainly affect, perhaps radically, both the pulsations of our heart and the respirations of our lungs.

Copper Etching Facts

IN the study of the microstructure of metals, the etching of the specimen is of fundamental importance. In the study of the general subject by the Bureau of Standards, copper was the first type to be considered. The principles underlying the etching of this metal are developed in a recent publication of the Bureau, Scientific Paper No. 390, and it is shown that oxidation is of prime importance. A list of typical etching reagents is given and the relative value of the various reagents is shown by means of illustrations of etching of various forms in which copper occurs.

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The object of this journal is to record accurately and lucidly the latest scientific, mechanical and industrial news of the day. As a weekly journal, it is in a position to announce interesting developments before they are published elsewhere.

The Editor is glad to have submitted to him timely articles suitable for these columns, especially when such articles are accompanied by photographs.

The Government Stepchild

THOSE who realize what a successful patent system means to American industry and American prosperity in general have once more succeeded in pushing their efforts in behalf of the Patent Office to the point where the Nolan Bill has emerged into the daylight of Congressional consideration. This bill is far from what those best acquainted with the situation would like; but on the principle that half a loaf is better than no bread they are working for it.

We do not know whether the general indifference to the fate of the Patent Office is due to lack of realization of its contribution to our position in our own markets and those abroad, or to failure adequately to picture its desperate condition. The questions asked at every Congressional hearing—asked year after year, despite the thorough fashion in which they are answered each time they come up—demonstrate colossal ignorance of the whole patent system, of its aims and its manner of achieving them. This ignorance exists not alone among those who have never had occasion to inform themselves and who therefore look upon the Patent Office merely as an agent for spending the Government's money for the benefit of a favored class, but equally among those who have been for years in contact with the facts.

The policy is plainly laid down in the Constitution and in the organic law of the land that it is the business of Government to encourage invention; that it is good business to do this and very bad business to omit it. If there still be any who believe that the patent creates an unjustifiable monopoly; who cannot understand that this monopoly is a just one and an expedient one; who still disbelieve that strong patents, and valid patents, and patents obtained within a reasonable time of filing, and prompt and efficient information service of the sort which only the Patent Office can be looked to to give, are among the strongest bulwarks of the proud position which the United States occupies in the industrial world, it would seem the part of supererogation to attempt further argument with these apostles of stubbornness. Accordingly, we say nothing on this side of the subject, confining our remarks to the effort to show, by new material and in its true colors, the truly desperate condition of the United States Patent Office.

Recently we published a brief account of the manufacture of synthetic rubber in Germany, by a process employing aluminum and acetone as basic raw materials. The present writer is anything but a chemist; but he was acquainted with the existence of this process, and had once been reasonably familiar with its general outlines, though these he had forgotten. On the appearance of the article we received a letter from one of the more competent patent examiners, a man of high standing, and one whom we happen to know as a good and conscientious worker. His field includes the subject of synthetic rubber. He gave us an awful calling down for printing this rubbish about aluminum and acetone. In all the references accessible to him in the Patent Office there was no mention of this thing, and he had never heard of such an absurd proposition as the manufacture of synthetic rubber from aluminum and acetone.

We want to emphasize that this is in no sense to the discredit of the man personally. It is altogether discreditable to the manner in which the needs of the Patent Office are being met—but that is all. The man of whom we speak is without doubt making an honest effort to keep up with the march of science in his field. But the demands upon his time and energy by routine work that ought to be performed by his subordinates, by executive work that ought to be performed by his equals and superiors, by the labor of instructing the vast and shifting army of temporary employees of low grade that occupy Patent Office vacancies at present salaries, by the work of examination and adjudication which properly falls on men of his class and of which he must shoulder more than one man's share—these demands make it out of the question for him to keep abreast of the times. If he could find the energy and the time to keep informed as he ought to, it is highly improbable that the Patent Office offers him more than half the necessary material, or makes this half decently accessible to him. With the present quarters, the present equipment, the present staff, the present salaries, the present working conditions, it is not possible for the Patent Office to function in any direction at anything approaching full power.

In 1848 the patent examiner was classified by law among the very highest grade of professional men. The Principal Examiners got the same salary as members of Congress; the Examiner in Chief got the pay of a United States District Judge. The requirements of these positions have not been lowered, as any one who will read one of the examination papers imposed upon applicants will testify; but the positions themselves have been far debased. In 72 years of rising costs, patent office salaries have been raised, barring a war-time bonus of $240 which is universal and temporary, exactly ten per cent. Today a first class patent examiner, if he is lucky, gets as much as a fairly competent bookkeeper or a properly unionized elevator runner. Case after case has come up in recent years where a competent examiner has left the service to go into commercial employment of identical character at a salary double what Uncle Sam was paying him. And the contrast in working conditions between patent examining on behalf of the people and patent soliciting on behalf of manufacturers is unspeakable.

A member of the British Patent Office staff won the Eugene Higgins prize of $5,000 for the best popular essay on the Einstein theories of relativity. This could never happen in Washington; after meeting the demands made upon him by his Patent Office work, no conscientious examiner would ever have time or mental energy to master the subject, let alone expound it.

In many respects the Nolan Bill is inadequate; but it has traveled so much of the path toward ultimate passage that whatever of relief it affords can be had quickly. Everybody who is interested in betterment of the disgraceful conditions in the Patent Office ought to get behind this bill. Write to your Senators and Representatives today and get everybody else whom you can influence to lend his weight in support of the bill.

Conditions of Success in the Merchant Marine

SINCE the Spanish War, that is to say, for nearly a quarter of a century, there has been a more or less persistent effort to awaken the United States to the need for a merchant marine. The steady, and in late years phenomenal, growth of our foreign trade necessarily gave increasing emphasis to this movement. Before the war, it was estimated that we paid out about 300 million dollars per year in freight charges to foreign-owned shipping companies, and it was urged that if we had our own ships, this large sum of money would be diverted to the United States.

Today we own such a fleet, but, unfortunately, its profitable operation is handicapped by shipping laws which impose such a heavy handicap upon American ships that they cannot possibly compete with those which fly a foreign flag. This is true, in spite of the fact that the general increase in wages throughout the world has brought this element in the cost of ship operations well up to the American level. Thus, thanks to the laws governing the operation of American ships, our splendid new merchant marine finds itself handicapped by having to carry much larger crews than its competitors. The accommodations for our seamen are more spacious and comfortable, and as to the way they are fed, the menu in the fo'castle of some of our ships would make many a city clerk or mechanic green with envy. This generous provision for the American seaman, so far as health and bodily comfort are concerned, is all to the good and will meet with approval; but anyone who is familiar with the problems of shipping operations will realize that this advancement of the conditions of housing, food and work imposes such a handicap upon our ships that, if we are to compete successfully with foreign-owned ships and to carry all of our own trade and a reasonable share of the trade of the world, it will be absolutely necessary for Congress to make good the difference in the shape of a very substantial annual subsidy from the national treasury.

Either that, or our shipping laws must undergo a drastic revision.

Hitherto, those of us who have striven to awaken the United States to the commercial and naval advantages that would follow from its possession of a powerful merchant marine have found that the mere mention of the word "subsidy" has acted like a spark in a powder magazine, except among the peoples who live along the seaboard and have an intelligent and sympathetic understanding of the shipping question. There is this difference, however, between the situation today and then. Formerly, we possessed no merchant marine. Today we possess a great fleet composed largely of recently-built and thoroughly up-to-date freighters representing, so far as the one-half of it owned by the Shipping Board is concerned, an outlay of about four billion dollars of Uncle Sam's money.

It is certain that matters cannot go on as they are. Today the operation of these ships is a losing proposition. We cannot go out of business, for one reason because nobody in these times of terrific depression and abnormally low freights would care to buy our ships at any reasonable figure. That being the case, what does the nation wish to do with this splendid property? Are we willing to sell the ships for a mere fraction of their cost? Shall we let them rest at moorings? Or shall we bring a little national pride into the matter and send these vessels, well equipped and manned by American crews, to display the American flag on all the seven seas, with the assurance that the taxpayers of the country are, to a man, behind the great venture and will cheerfully make good a deficit which is largely due to world conditions over which we have no control.

Reducing the Bill for Federal Printing

HOW many people are aware that by far the greatest printing establishment in the world is located at Washington and run by the Federal Government? Furthermore, how many of us know that the annual bill for Federal printing reaches the huge total of 14 million dollars?

The Government Printing Office is engaged in printing that unique publication known as the *Congressional Record*, a stupendous undertaking in itself. In addition to this, it sends out by the ton various Government documents. Now, the annual cost of turning out printing at this rate is about 12 million dollars, and in addition to that, outside printing is done for the Government to the tune of two million dollars per year.

There is no question that the extravagance which marks all Governmental work has been flagrantly evident in connection with this outside printing. Mailing lists are not kept up to date, and consequently, members of Congress, the public press and many individuals who have no use for much of this printed matter, continue to receive it regularly year after year. And there is the tendency of Government officials, outside of those who are members of Congress, to have their speeches and pronouncements printed for broadcast distribution. We learn that from July 1, 1916, to September 15, 1919, the total number of speeches thus printed at public expense reached a figure of over 30 million copies, calling for over 894,000 pounds of white print paper and 558,000 pounds of manila envelope paper. The total cost of this item alone was 443,000 dollars. It is to be hoped that the committee which has this matter in hand will put in the pruning knife with a ruthless hand. We can call to mind no other waste of public moneys that has been so stupidly wilful as this.

Electricity

A Voltmeter Improvement is evident in the recent offering of a British electrical instrument manufacturer. This improvement takes the form of a six-range switch which gives values for the calibrations of the single scale of from .001 to 1,040 volts. The switch handle is made in the form of a flat rod, which may be pulled more or less out of its slot in the side of the instrument case. A series of graduations on the side of this slide indicates how the scale reading should be multiplied in order to obtain the correct value for any setting.

Electric Truck for Foundry Use.—A storage-battery truck of exceptionally rugged construction has recently been developed for foundry use, such as in packing and transporting pots in the process of making malleable castings. The truck has a carrying capacity of 4,000 pounds. The lift mechanism is a completely enclosed unit, all parts of which run at slow speed in oil baths. The driving unit consists of a totally enclosed motor directly connected to a worm gear driving through a four-bevel pinion differential to the wheels. All units are standardized and built on an interchangeable system. The complete unit is 12 feet over all in length and weighs 3,600 pounds.

Transatlantic Radio Telephony.—The realization of transatlantic telephony for commercial purposes is another object of the radio central installation, according to E. F. W. Alexanderson, the well-known radio engineer. Transatlantic telephony will, no doubt, be a luxury for some time to come. The radiation intensity needed for telephony is much greater than for telegraphy, and a plant designed purely for telephony might prove prohibitively expensive. However, the flexibility of the radio central where any number of antennæ can be combined when desired to produce a more efficient radiation will make an extra powerful transmitter available when needed, while the plant may be used in a more economical way at other times for telegraphy.

Flameproof Motors.—Experiments have been under way in England with a view to finding a means of protecting motors and other electrical equipment with a form of enclosure which, although affording a vent to relieve the force of an internal explosion, would not communicate a flame to the outside. Results have been obtained by flange, gauze and plate projection, but it appears that further research is necessary before there is conclusive evidence that any particular design can be relied upon to produce complete protection. There is a genuine demand for a flameproof motor in modern coal mining operations, in chemical works, and in motion-picture laboratories where vast masses of highly inflammable film are imperiled by the proximity of unprotected electric motors.

A Switch with Indicator Contacts meets the requirements when it is important to provide for the indication at some remote point of the position of a disconnecting switch. Such an indication is often of value at the point of control of circuit breakers in series with the disconnect, and serves as a positive check on visual inspections that have been made previously. In the new switch a separating insulating tube serves to provide for the making of an auxiliary contact with a small switch operated by the main blade. This secondary contact closes and opens the circuit of the signal lamps located at the distant point or points. The circuit through the auxiliary switch is not fully closed until the main switch blade is in a fully open or closed position. A positive safety lock prevents the accidental movement of the disconnect after it has been properly set.

A Radio Call Signal has been developed by the British Post Office which is claimed to be particularly free from liability of interference from jamming or atmospherics, according to *The Technical Review*. The arrangement employs a single valve note magnifier and a thermo-ionic trigger relay, such as that described recently before the Institution of Electrical Engineers by Capt. L. B. Turner, and its special feature is a retardation device which prevents the call bell being operated before an uninterrupted "dash" 15 seconds in duration has been received. The current from the Turner relay actuates an ordinary Post Office electromagnetic relay, which starts charging a condenser through a very high resistance. It is only when this condenser is sufficiently charged that the dropping off of the first P. O. relay will cause the discharge of the condenser to affect a second P. O. relay, which in turn rings the call bell. The method of retardation depending upon charging a condenser slowly through a high resistance has been used by the Post Office on call signals for submarine cable circuits for some years.

Science

Bigger Women?—The director of Physical Education at the University of Pennsylvania states that statistics of women's colleges covering a period of sixty years show the average college girl of today is an inch taller than the college girl of 1860. These statistics also prove the modern girl is six or seven pounds heavier.

Shipping Explosives.—The Forest Products Laboratory specially designed a box in which to transport TNT and the box-testing machine which we have already illustrated has been used in making the tests. Boxes which are being tested and which will probably be accepted are approximately one foot square and eighteen inches long.

Nitration of Unbleached Pulp.—The series of tests to determine the suitability of woodpulp for nitrocellulose that have been in progress for some time at the Forest Products Laboratory indicate that bleached soda and sulphite pulps contain a comparatively high percentage of beta-cellulose and that cellulose from wood and cellulose from cotton represent different chemical aggregates. Nitration tests on unbleached pulps indicate that bleaching is unnecessary.

An Electric Scoreboard for Registration of Votes is now being considered by the Legislature of the State of New York. This would permit a quick and accurate count of votes cast, in addition to calling the roll. The only danger is that the electrical flash would be unrecorded. But this difficulty has been overcome by having the signal registered by a photostat, which is perfectly feasible. Each assemblyman would have three push buttons, one for "present," one for "no," and one for "yes."

Elevator Accidents.—Considering the number of elevators in New York City, 13,500 in all, the percentage of accidents is very small indeed. On each of the three hundred and thirteen working days of 1919, six million passengers were carried through the 10,000 miles of elevator shafts, making a total of 1,878,000,000 passengers for the year, but only one passenger out of every 87,500,000 was killed in the elevator trips. This is owing to the excellent inspection by the office of the Superintendent of Buildings and also by the insurance companies.

An Interesting Exhibit is being held at the American Museum of Natural History to show the probable structural changes in the evolution of the forelimb from the wing to the paddle. Take for example the ancestry of the penguin, in which there was a forelimb modification before the flipper-like wing of the penguin was developed. To be adapted for flying, a limb must be light and at the same time strong enough to support a large surface of membrane or feathers spread for flight. For this reason the wing-bones of birds of flight are hollow, slender and long, but for swimming a limb must be strong and furnish support for a comparatively narrow paddle, so the bones are solid, short and stout.

Famous Trees.—The American Forestry Association announces a list of trees that have been placed in its hall of fame for trees with a history. The idea is to preserve famous historical trees and to mark the dates that had a great influence on American history, such as the arrival of John and Charles Wesley in America. The tree under which Wesley preached is an oak tree still standing on St. Simon's Island. The Webster tree is the tree on which the great orator hung his scythe, when he finally decided to go to Dartmouth College. To mark the 115th anniversary of the pathfinding expedition of Lewis and Clark, a tree has been selected where they held one of their first councils with the Indians after leaving St. Louis. The tree was 150 years old at least before Lewis and Clark camped below it. Nominations to the Hall of Fame are made by various associations all over the country.

The State of Russian Science.—A movement is being started to provide Russian scientists and men of letters with literature which they missed so sorely. A certain amount of scientific research and some literary work still goes on notwithstanding the Bolsheviki, who are losing some of their hostility to scientific and literary work, and what is left of the once flourishing scientific life of Russia has now been brought together into two special rationing organizations which insure at least the bare necessities of life for them. Several scientific men have been particularly interviewed as to whether anything could be done to help them, as practically no books or publications have been received from abroad since the revolution. A strong committee of British scientists and literary men have been formed and there is now no obstacle for the transmission of this needed material.

Industrial Efficiency

American Coal in Northern Europe.—Opinions as to the prospect of the sale of American coal in northern European markets vary somewhat, but agree on the whole in the idea that the trade in the near future will assume a pre-war nature and condition except that it is likely to be in much larger volume—that is, the demand will be mostly, if not entirely, for special grades of coal for technical use, particularly for the manufacture of gas.

Corrugated Wire Glass.—By incorporating slight corrugations or ripples in wire glass, a leading wire glass manufacturer claims that he has evolved a glass that throws the light all over the building. Again, this glass is stronger and more durable, being made in one solid piece and not in layers with the wire between. It does not require special roof members for installation and can be used in connection with other corrugated materials for sky lights, side walls, and roofs.

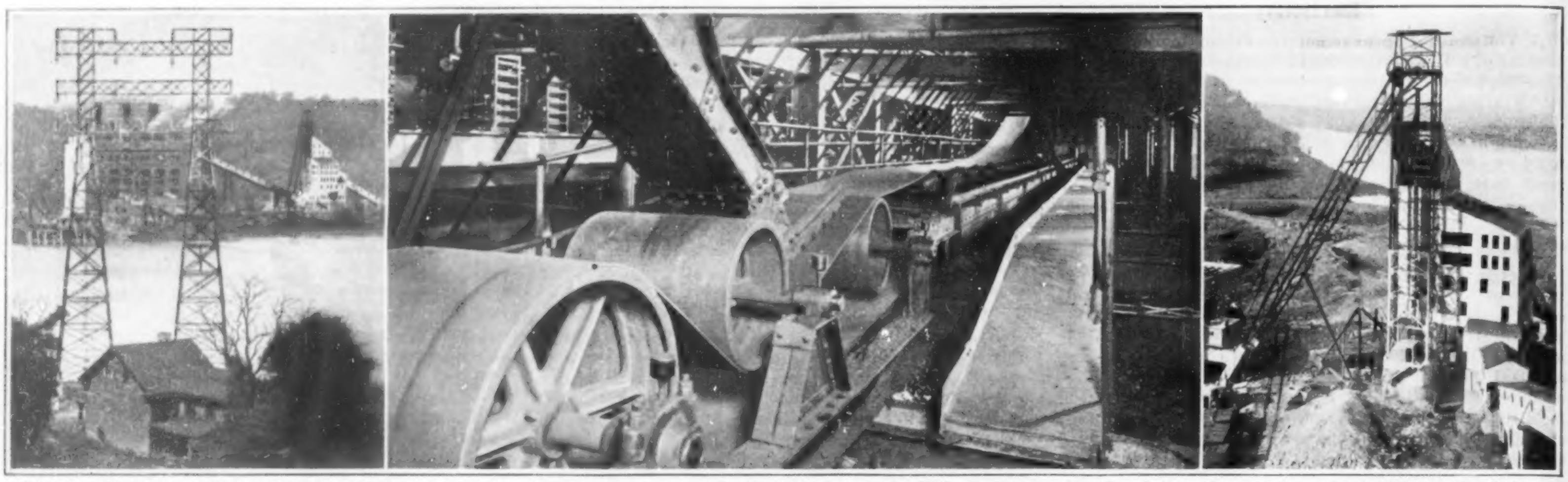
A Substitute for Cork.—A chemical works at Bruenn-Koenigsfeld has been carrying on experiments with a view to finding a substitute for cork, says a Prague correspondent in the *Times Trade Supplement*, and these have now led to tangible results. Turf treated by a special patented process furnishes a material for insulation and building purposes that is said to be, in most respects, not inferior, and in some superior, to cork. The product is reported to be equally light, firm, and sound-proof, to possess great insulating properties, and to be damp-proof.

Oiling Shafts from the Floor.—Accidents often result in the course of oiling transmission shafts in the usual way, namely, atop a lofty ladder. With a view to eliminating the necessity of using a ladder for oiling shafts, an American company has recently introduced a long-distance oiler, so to speak, which can be operated by the man standing on the floor. A long tube, curved at the top, connects with the oil can, which is held in one hand while the tube is guided to the oil cups above with the other hand. The oil is forced up the tube by air pressure.

The Portable Elevator has come into its own of late, especially since the scarcity of buildings compelled manufacturers and others to utilize their space to the utmost. Portable elevators are now being employed for no end of purposes, such as piling barrels, cases, bags, bales, machine parts, and crates. Any goods, bags included, may be piled up to the ceiling—straight up from the aisle. "Stepping" the packages or bags and wasting half the space along the aisles has been eliminated through the use of the portable elevator. Thus the storage space has been increased without a single change in floor space.

Wire Partitions for the Factory.—Security, order, efficiency—three things that go a long way toward making any plant what it should be—are gained through the use of partitions of some sort in order that tools and materials may not be lost, misplaced, or stolen. Again, where partitions divide each department into a working unit, there is less friction between workers. All unite to give the systematic effectiveness that is the aim of every factory executive. To simplify the partition problem, there has been introduced on the market a system of sectional wire partitions which enables any one to erect stock rooms, tool rooms and divisions quickly and with the least trouble and expense. Every section is a complete standard unit, facilitating erection on the one hand, and changes on the other. Such partitions provide the security of a wall, yet obstruct neither light nor air.

An International Chamber of Commerce has been formed at a Paris meeting as the result of the International Trade Conference held at Atlantic City a year ago. The constitution of the International Chamber as adopted by the convention provides for strong national organizations which will assure the due representation of the main economic forces of each country represented. A board of directors, consisting of three members selected from each of the countries, Belgium, France, Great Britain, Italy, and United States, will serve for a period of three years. The board of directors may select a limited number of additional directors from countries not already represented on the board. Paris was chosen as the international headquarters, a fine building situated at 3 rue Jean Coujon having been secured for the purpose. The purpose of the International Chamber of Commerce, as defined by the constitution, is as follows: "To facilitate the commercial intercourse of nations, to secure harmony of action on all international questions affecting commerce and industry, and to promote peace, progress, and cordial relations among countries and their citizens by the coöperation of business men and their organizations devoted to the development of commerce and industry."



The transmission tower that carries the power lines from the generating plant across the Allegheny River. 2. End of the conveyor that brings the coal from the heading to the firebox. 3. The shaft head of the Springdale development

How coal is being burned at the mine mouth to provide power for a wide area

Shipping Coal by Wire

The Springdale Undertaking—A Great Power House at the Mine Mouth

By Robert G. Skerrett

GENERATING power on a large scale at the mine mouth is one of the economic strides forced upon us by our participation in the World War. Recently a master central station of this character started service at Springdale, Pennsylvania, on the Allegheny River, some miles above Pittsburgh. It is typical of what we are rapidly coming to in an effort to conserve coal, to cut down transportational charges, and to enable us to distribute energizing current at a moderate price throughout a wide radius of application.

It has been authoritatively declared that to mine 90,000,000 tons of anthracite in the course of a year involves the consumption in isolated steam plants at the mines, of quite 9,000,000 tons of coal, while if the needed power were generated for this service at a great central plant only 1,000,000 tons of fuel would be required. That is to say, it would be possible by such a procedure to effect a saving of substantially 89 per cent! With these facts before us it is comparatively easy to appreciate the significance of the Springdale Station, which is intended to furnish electricity to a considerable number of mines and to steel mills and steel furnaces lying within its zone of distribution. The ultimate machine capacity of the station will be about 300,000 kilowatts, and, in a general way, it typifies the master central plants that are contemplated for the proposed superpower zone of the northeastern Atlantic States.

The Springdale Power Station is the outcome of a contract entered into between the Government and the power company in the latter part of 1918. At the time of the agreement the Federal authorities pledged themselves to advance 40 per cent of the cost of the undertaking, this coöperation being essential to promote the prompt start of the enterprise. The scheme broadly was to aid the Pittsburgh district in manufacturing the basic materials for munitions, ships, etc., and to stimulate the output of coal for use elsewhere throughout the country. While the rearing of the structure and its equipping were effected too late to serve these ends during the period of strife, the station will, nevertheless, be a source of industrial strength for years to come.

The successful operation of a great central station within easy reach of coal is not solved merely by placing such a plant in the heart of a coal field and next door to a mine mouth. It is equally indispensable that there be immediately available an ample supply of water for condensing purposes, so that the hot water obtained by condensing exhaust steam can be led back to the boiler feed, thus lessening the amount of fuel to be burned to bring that water up again to the boiling point. The bigger the steam plant the greater the amount of water needed for this service. Accordingly, the Springdale powerhouse was placed right on the Allegheny River from which the filtering system draws a million gallons daily. This installation is designed to deal with the acid condition of the river water when the Allegheny is low; before the water reaches the boilers it passes through evaporators which dispose of harmful impurities or troublesome mineral matter in suspension.

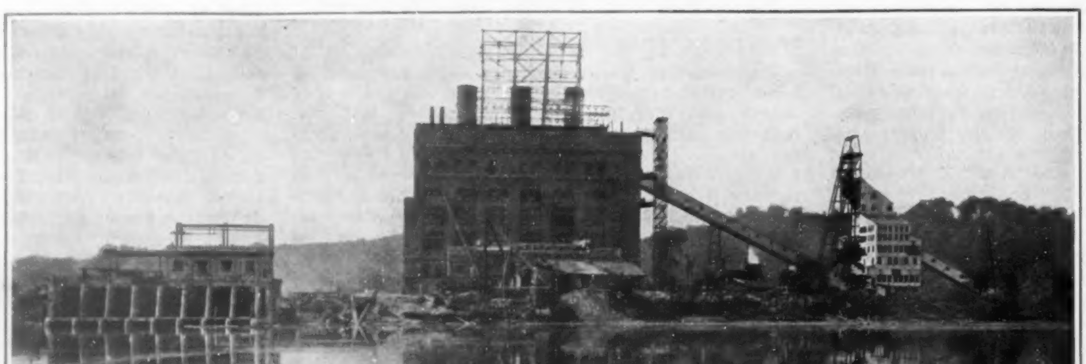
The boilers are of the watertube type, each having 15,290 square feet of heating surface, equipped with a superheater, and capable of maintaining a working pressure of 350 pounds. Coal is delivered to these big steam generators by gravity from elevated bunkers, the fuel descending through chutes to underfeed stokers. Soot blowers keep the boilers clean so that they can run continuously at maximum efficiency for a month without any of them being shut down. The automatic stokers are driven by electric motors. The ashes are handled mechanically and drop into a large tank or hopper containing water, where they are immediately quenched. From this pit the ashes are withdrawn by bucket dredges and dumped into cars for removal. The point to be kept in mind is that only a handful of operatives is necessary in the fireroom and to deal with the ashes.

At the present time, the outgoing power service is taken care of by two of the latest models of steam turbo-generators, each of which is rated at 25,000 kilowatts, that deliver current at 12,000 volts to the busbars of the transmission system. In addition to these, there is installed a 2,500-kilowatt steam turbo-generator which furnishes energy for numerous electrically-driven auxiliaries. The adoption of electric in place of steam drive eliminates a great deal of piping and does away with the radiation losses and leakage incident to the use of steam. This arrangement makes for marked economy in coal consumption. The house turbine, in case either of the main generators should be shut down, can be put on the line to help to meet the load.

Probably one of the most interesting features of the Springdale Power Station is its source of fuel and the manner in which the coal travels from underground to the capacious bunkers situated high above the boilers. The bed of coal that is being worked lies close by and extends under the river, the operating tunnels passing from shore to shore at a depth of 90 feet. The delivery or hoist shaft is just to the north of the powerhouse, and over this shaft rises the tipple which crushes and assorts the coal preliminary to passing it on to belt conveyors which carry the fuel to the station bunkers or to the neighboring storage yard. The belt conveyors, crushers, screens, elevators, etc., are all of them functioned electrically.

The vein of coal, which will probably suffice to meet the wants of the plant for half a century, has a general vertical thickness of $7\frac{1}{2}$ feet, and the fuel averages 13,250 British thermal units per ton. The seam runs below strata of carbonaceous slate and sandstone —the latter about 25 feet through, and above this formation is a heavy bed of gravel. The sandstone, so far as exploratory borings reveal, is devoid of fissures, and, therefore, it is not expected that the miners will encounter any serious leakage from the river flowing past overhead. As a matter of precaution, nevertheless, drill holes are being sunk 75 feet in advance of the headings for the purpose of detecting any fractures in time to check inflowing water by means of compressed air. When the coal in the line of the tunnels has been removed, as the miners progress from west to east, the seam will then be followed throughout the property situated on the far shore, and the tunnels will thereafter serve as transportational channels through which the mine cars will travel to and from the hoist shaft connected with the tipple.

It will probably be wondered why the central station was placed on one side of the river while the coal field lies, in the main, beneath the opposite shore. This is easily explained. The site chosen for the structure was one of the few remaining good-sized tracts of land on the Allegheny River suitable for manufacturing purposes. It embraces an area of 80-odd acres overlying a rock formation and well above the sweep of the normal water level. As will be seen, in digging the tunnels, the power com- (*Con'td on page 155*)



General view of the Springdale mine-mouth power house

How Pullman Space is Sold

By A. R. Surface

MOST of us have stood in front of a ticket window while the agent dickered over the telephone with a mysterious central authority somewhere for the privilege of selling us Pullman accommodations; and most of us have doubtless wondered just where this arbiter of our fate was located and just what sort of system it was that governed the business of making and selling these reservations. Those of us who have got aboard the train to find another in possession of the berth for which we held a coupon, with a porter and a conductor supremely indifferent to our protestations, will perhaps be willing to credit the statement of the *New York Central Magazine* that the systems in use heretofore have not been very satisfactory. But according to this authority, the scheme lately put into effect for the control of all Pullman business out of the Grand Central Station is as effective and as simple in operation as it is elaborate in design.

The Pullman central office where all reservations for trains out of the Grand Central are made and recorded

The equipment—all of which was specially devised and made to order for this purpose, even to the telephone arrangement—centers at a distributing board 18 feet long, 3½ feet wide and 2½ feet high. This for its whole length is surmounted by a rack containing pigeonholes which accommodate 190 sets of diagrams for as many different outgoing cars.

The distributing board is divided into three sections, and the whole table surrounded by comfortable, low swivel chairs for the twelve operators. Each of the three sections contains the diagrams of all Pullman cars of certain trains; there are four distributors for a section, each operator being assigned certain trains. On the table in front of the distributor is a duplicate set of index lights and she is fitted with head receiver and mouthpiece.

The perfection of the plan involved the installation of a very simply operated but most elaborately constructed special telephone system by the engineers of the New York Telephone Company. The ticket offices at Grand Central Terminal and 125th Street Station, and the Consolidated Ticket Offices at 64 Broadway, 57 Chambers Street, 31 West 32nd Street, 114 West 42nd Street, New York; and 336 Fulton Street, Brooklyn, all are connected by direct wires leading to the distributing table. In turn each ticket-seller in the various offices is furnished with a card "key" showing just where the diagrams for each car and train are located on the distributing board. His equipment also includes an individual telephone and set of buttons placed at his station at the counter or ticket window. By pressing the proper button, the distributor is signaled in the section in which it is desired to obtain space, and the business is thereupon immediately completed by telephone.

A formula, adopted to reduce the number of words used in the operation, results in each transaction's being conducted in a few seconds, with the possibility of error reduced to a minimum.

For example: A lower berth is desired on the "Twentieth Century Limited," Train No. 25, Thursday, April 10th, New York to Chicago. The following cryptic conversation goes over the wire between the ticket-seller and the clerk at the Pullman distributing center:

Ticket Seller: "25, Chicago, Thursday, April 10th, lower."

Pullman Clerk at Distributing Board: "All right" (indicating that he can fill the order).

Seller: "1776" (number of railroad ticket).

Clerk: "Lower 12, Car 42, 25, Chicago, Thursday, April 10th, 1776."

Seller: Repeats this.

While this is being repeated, the Pullman clerk checks with the diagram as data is called. The ticket number is recorded on the car diagram before the space is given to the ticket-seller. The staff of operators is composed of picked experts.

There are many advantages gained for the buyer as well as the seller by the new system. No longer must the traveler stand in line before a Pullman window, while he waits his turn to purchase a ticket for chair or berth. When he buys his railroad ticket the same clerk is able to fit him out with Pullman space, and, in addition, the passenger knows immediately whether the desired accommodations are available. Orders are taken for any advanced period.

The general public's telephone calls for Pullman accommodations are received also in this same office, but are received by a separate set of operators at another receiving table.

Because of this concentration of distribution, space may be sold until two minutes before leaving time, when the diagrams are sent by a messenger to the trains. Furthermore, the manager is able to determine at any moment when it is necessary to add a car or more.

The absence of bell-ringing and buzzers in the offices must be of untold comfort to the busy agents and the traveling public already has shown by many appreciative expressions its realization that the securing of Pullman space has been greatly simplified.

A Rural School Museum

By Edmund Conaway

ANY part of a rural school can be a museum and since the whole of out doors is to choose from, little trouble should be experienced in making a selection. Many people think that a museum should consist of a collection of specimens kept in a building, costing at least twenty thousand dollars. Such is not the case, since a museum does not need to be in a city or cost a large sum of money.

Many rural schools have good collections of agricultural products, but there are many more things that should be added. It is reasonable that the best collections should always be of the community in which the school is situated. If agricultural the collection should be the best produced. In coal mining communities, lumps of coal on which are found the prints of ferns or other forms of vegetable life. This shows that coal was formed from vegetation and would also furnish material for an interesting lesson in the coal industry. Those who live in the vicinity of oil fields can easily collect a bottle of crude oil and also sand from which the oil was produced. This would be helpful in a lesson pertaining to the oil industry.

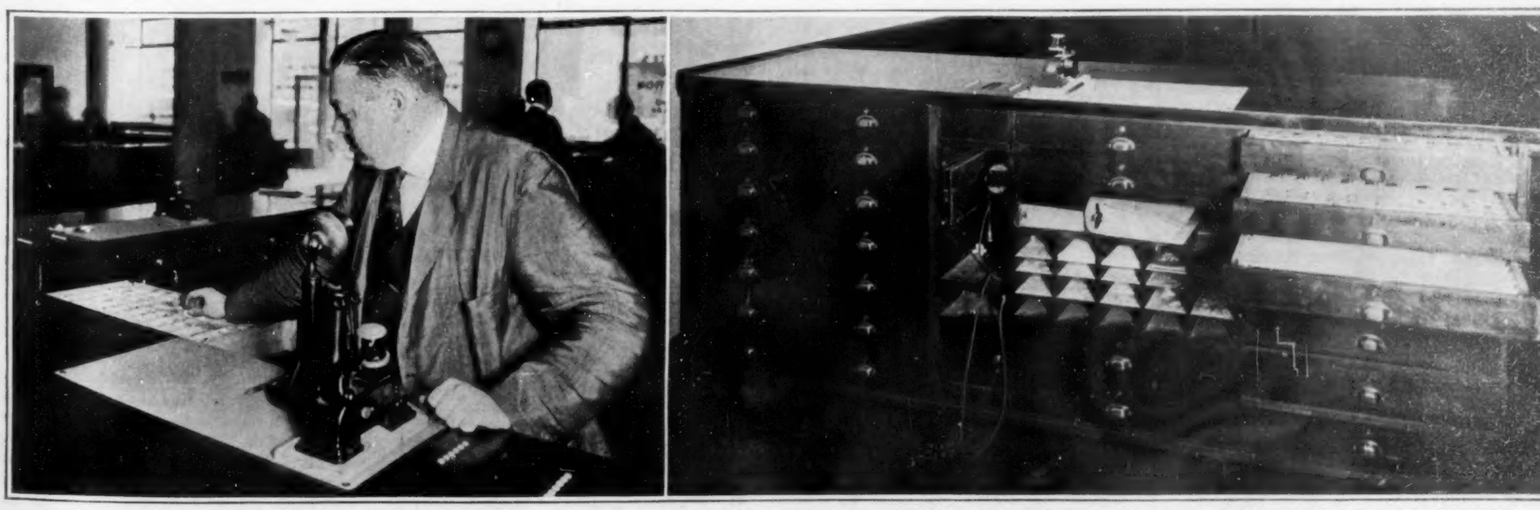
There are many things of historical interest in every community that could easily be collected, such as Indian relics, consisting of arrow heads, tomahawks and other implements of warfare. These are found about the camping places of Indians which are known in most communities. Most everyone living in the rural district has found some of these objects which he or she would be glad to contribute. These would be helpful in teaching the important subject of local history.

There are streams in every community along which are found stones of all sizes and shapes. Occasional collections of these should be made, accompanied by the children in order that they might have a better idea as to how they were formed.

In the collection might be the head of a dog, sheep or goat and also the skeleton of any bird that could be found. There should also be small pieces of different trees showing a cross-section with the annual rings of growth. The annual ring of growth is defined as "The layer of wood produced by the diameter growth of a tree in one year, as seen on a cross-section." Under normal conditions one ring is produced each year. Trees that grow fast have wide rings distinctly marked, while those of slow growth have very narrow rings that can hardly be distinguished. These rings would enable the teacher and pupils to determine the age of various trees and to make a study concerning their growth.

The people of a school in one section of the United States could easily collect specimens from those of another. People of the North and East know very little about the growth of cotton and peanuts. A teacher could write to a postmaster of some town in the South or Southwest, asking for the name of some one who might send these plants.

(*Continued on page 155*)



Left: The ticket seller with his automatic telephone, by means of which he can make instant connection with the Pullman clerk who has charge of the train in which he is interested.
Right: The same view from behind the scenes, showing the place where the 'phone reposes when not in use.

The equipment by aid of which the ticket agent can make Pullman reservations in a few seconds while selling the ticket

The New Concepts of Time and Space

A Brief Account of What Einstein Has Done to These Fundamental Notions

By Jumbo (Montgomery Francis, New York)

WHAT we present here, though altogether a praiseworthy effort, is not necessarily the second-best of the Einstein essays. We have selected it for this prominent position, perhaps because it is the one already referred to as appealing to our personal taste, but rather, we hope, because it seems to us of all the essays the one best suited to supplement the winner's. Like Mr. Bolton, Mr. Francis is obliged to bring in points which he has not the space to develop fully, and to suggest viewpoints which it is not possible for him to set forth in detail. The topics which he does discuss fully, however, are just the ones which Mr. Bolton slides over or excludes entirely, while he has comparatively little to say in duplication of the paragraphs in which Mr. Bolton spreads his subject in greatest detail before the reader.

The Judges and the present reviewer are united in admiration of the amount of material which Mr. Francis has compressed within the limits of 3,000 words. In this respect he stands easily at the head of the procession. Indeed, his essay is so closely written that we are in some doubt whether this should be regarded altogether as an unalloyed virtue. Certainly if its literary merit were any less, the compactness of his essay would make its reading a matter of some difficulty.

In justice to all concerned, we ought to say that the subheads and the two bracketed sentences in Mr. Francis' essay, together with his references to our article of December 4th, have been supplied editorially.—THE EINSTEIN EDITOR.

WE have all had experiences, on trains and boats, illustrating our inability to tell, without looking off to some external body, whether we are at rest or moving uniformly; and when we do so look, to tell, without reference to the ground or some other point external to both systems, whether ours or the other be the seat of motion. Uniform motion must be relative, because we find nowhere in the universe a body in the unique state of absolute rest from which alone absolute motion might be measured.

True, the wave theory of light with its homogeneous space-filling ether seemed to provide a reference standard for the concept of absolute motion, and for its measurement by experiment with light rays. But when Michelsen and Morley looked for this absolute motion they found no trace of it. (SCIENTIFIC AMERICAN, June 12, 1920, p. 646, "Checking Up Einstein.") To the physicist, observational student of the external world, nothing exists save observationally; what he can never observe is not there. So: I. *By no means whatever may we regard uniform straight-line motion as other than relative.*

As a further direct consequence of the Michelsen-Morley experiment we have: II. *Light in a vacuum presents the same velocity, C = 186,330 miles per second, to all observers whatever their velocity of relative motion.* In addition to being experimentally established, this is necessary to support I, for if light will distinguish between our velocities, its medium is necessarily a universal standard for absolute motion. But it is contrary to common sense to suppose that if I pass you at 100 miles per hour, the same light impulse can pass us both at the same speed, C. We feel, instinctively, that space and time are not so constituted as to make this possible. But the fact has been repeatedly demonstrated. And when common sense and fundamental concepts clash with facts, it is not the facts that must yield. We have survived such crises, notably one where we had to change the fundamental concept of up-and-down (SCIENTIFIC AMERICAN, Dec. 20, 1919, p. 602, "The Nature of Things"); if another one is here, says Einstein, let us meet it.

This the Special Theory of Relativity does. It accepts Postulates I and II above; their consequences it deduces and interprets. For extensive demonstration of these I lack space, and this has been satisfactorily done by others so it is not my chief duty; but clearly they will be startling. For the very ray of light which refuses to recognize our relative motion is the medium through which I must observe your system and you mine.

It turns out that I get different values for lengths and time intervals *in your system* than you get, and vice versa. And we are both right! For me to accept your "correction" were for me to admit that you are at absolute rest and I in absolute motion, that your measure of light velocity is right and mine wrong: admissions barred by the postulates. We have nothing to correct; we can only recognize the reason for the discrepancy; and knowing our relative velocity, each can calculate from his own results what the other's will be. We find, of course, that at ordinary velocities the discrepancy is many times too small for detection; but at relative velocities at all comparable with that of light it rises above the observational horizon.

To inquire the "true" length is meaningless. Chicago is east of Denver, west of Pittsburgh, south of Milwaukee; we do not consider this contradictory, or demand the "true" direction of Chicago. Einstein finds that the concept of length, between points in space or events in time, does not as we had supposed represent an intrinsic property of the points or the events. Like direction, it is merely a relation between these and the observer—a relation whose value changes with the observer's velocity relative to the object. If our ideas of the part played in the world by time and space do not permit us to believe this, we must alter those ideas. [Let us see how we may do this.]

A Word of Points

To deal with points in a plane the mathematician draws two perpendicular lines, and locates any point, as P, by measuring its distances, X and Y, from these "coordinate axes." The directions of his axes acquire for him a peculiar significance, standing out above other directions; he is apt to measure the distances X — x and Y — y between the points P and Q in these directions, instead of measuring the single distance PQ. We do the same thing when we say that the railroad station is five blocks north and two east.

The mathematician visualizes himself as an observer, located on his coordinate framework. For another observer on another framework, the horizontal and vertical distances X'—x' and Y'—y' between P and Q are different. But for both, the distance from P direct to Q is the same. In each case the right triangle PQM (or PQM') tells us that:

$$PQ = \sqrt{(X - x)^2 + (Y - y)^2} = \sqrt{(X' - x')^2 + (Y' - y')^2}$$

Imagine an observer so dominated by his coordinate system that he knows no way of relating P with Q save by their horizontal and vertical separation. His whole scheme of things would be shattered by the suggestion that other observers on other reference frames find different horizontal and vertical components. We have to show him the line PQ. We have to convince him that this length is the absolute property enjoyed by his pair of points; that horizontals and verticals are merely relations between the points and the observer, result of the observer's having analyzed the distance PQ into two components; that different observers effect this decomposition differently; that this seems not to make sense to him only because of his erroneous concept of a fundamental difference between verticals and horizontals.

We too have created a distinction in our minds corresponding to no sufficient reality. Our minds seize on time as inherently separable from space. We see the world made up of things in a continuum of three space dimensions; to make this dead world live there runs through it a one-dimensional time continuum, imposed from without, unrelated.

The Four-Dimensional World of Events

But did you ever observe anything suggesting the presence of time in the absence of space, or vice versa? No; these vessels of the universe always occur together. Association of the space dimensions into a manifold from which time is excluded is purely a phenomenon of the mind. The space continuum cannot begin to exist until the time dimension is supplied, nor can time exist without a place to exist in.

The external world that we observe is composed, not of points, but of events. If a point lacks position in time it does not exist; give it this position and it becomes an event. This world of events is four-dimensional—which means nothing more terrifying than that you must make four measures to locate an event. It does not mean, at all, that you must visualize four mutually perpendicular lines in your accustomed three-space or in a four-space analogous to it. If this world of four dimensions seems to lack reality, you will be able to exhibit no better reality for your old ideas. Time belongs, without question; and not as an afterthought, but as part of the world of events.

To locate an event we use four measures: X, Y and Z for space, T for time. Using the same reference frame for time and space, we locate a second event by the measures x, y, z, t. Minkowski showed that the quantity

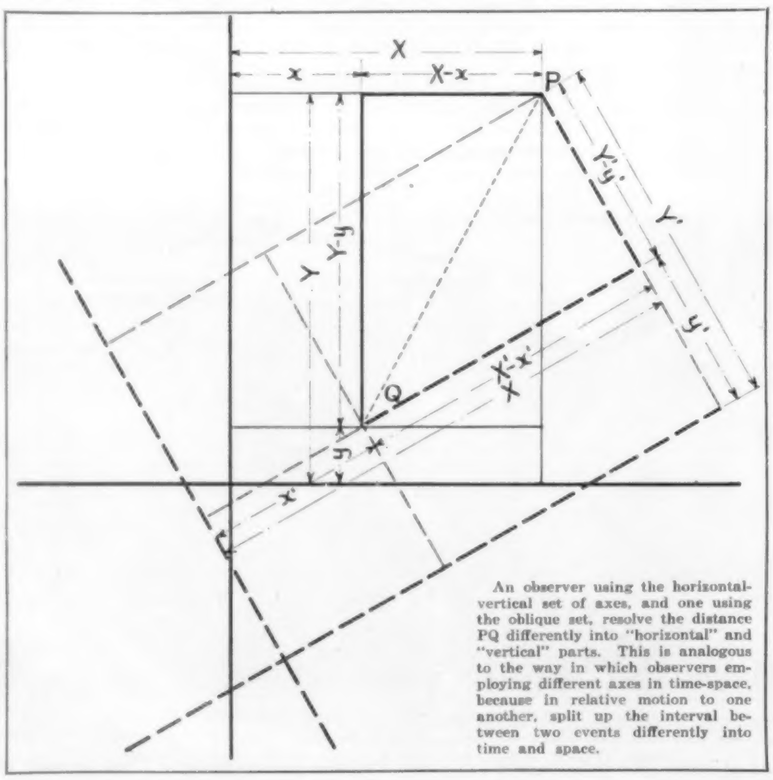
$$\sqrt{(X - x)^2 + (Y - y)^2 + (Z - z)^2 - (CT - Ct)^2}$$

is the same for all observers, no matter how different their x's, y's, z's and t's; just as in the plane the quantity

$$\sqrt{(X - x)^2 + (Y - y)^2}$$

is the same for all observers, no matter how different their x's and y's.

Such a quantity, having the same value for *all* observers, is absolute. In the plane it represents the true, absolute distance between the points—their intrinsic property. In dealing with events it represents the true, absolute "interval," *in time and space together* between the events. It is not space, nor time, but a combination of the two. We have always broken it down into separate space



An observer using the horizontal-vertical set of axes, and one using the oblique set, resolve the distance PQ differently into "horizontal" and "vertical" parts. This is analogous to the way in which observers employing different axes in time-space, because in relative motion to one another, split up the interval between two events differently into time and space.

and time components. In this we are as naive as the plane observer who could not visualize the distance PQ until it was split into separate horizontals and verticals. He understood with difficulty that another observer, employing a different reference frame because in different position, would make the decomposition differently. We understand with difficulty that another observer, employing a different reference frame because *in uniform motion relative to us*, will decompose the "interval" between events into time and space components different from ours. Time and space are relative to the observer; only the interval representing space-time is absolute. [So common sense stands reconciled to the Special Theory of Relativity.]

Successive Steps Toward Generality

Is then our laboriously acquired geometry of points in a three-dimensional space to go into the discard? By no means. Jeans, investigating the equilibrium of gaseous masses, found the general case too difficult for direct attack. So he considered the case where the masses involved are homogeneous and incompressible. This never occurs; but it throws such light on the general case as to point the way toward attack on it.

Euclidean geometry excludes motion, save that engineered by the observer; and then the time is immaterial. Time does not enter at all; the three space dimensions suffice. This simple case never occurs where matter exists; but its conclusions are of value in dealing with more general cases.

When we look into a world alleged to be that of Euclid and find motion, we may retain the Euclidean concept of what constitutes the world and invent a machinery to account for the motion; or we may abandon the Euclidean world, as inadequate, in favor of a more general one. We have adopted the second alternative.

Newton's laws tell us that a body free to move will do so, proceeding in a straight line at uniform velocity until interfered with. We do not ask, nor does the theory tell us, whence comes the initial motion. There is no machinery to produce it; it is an inherent property of Newton's world—assured by the superposition of the time continuum upon Euclid's world to make Newton's, accepted without question along with that world itself.

But Newton saw that his world of uniform motion, like Euclid's, was never realized. In the neighborhood of one particle a second is interfered with, forced to give up its uniform motion and acquire a constant acceleration. This Newton explained by employing the first of the alternatives mentioned above. He tells us that in connection with all matter there exists a force which acts on other matter in a certain way. He does not display the actual machinery through which this "force" works, because he could not discover any machinery; he had to stop with his brilliant generalization of the observed facts. And all his successors have failed to detect the slightest trace of a machinery of gravitation.

Einstein asks whether this is not because the machinery is absent—because gravitation, like position in Euclid's world and motion in Newton's, is a fundamental property of the world in which it occurs. His point of attack here lay in precise formulation of certain familiar facts that had never been adequately appreciated. These facts indicate that even accelerated motion is relative, in spite of its apparently real and absolute effects.

Gravitation and Acceleration

An observer in a closed compartment, moving with constant acceleration through empty space, finds that the "bottom" of his cage catches up with objects that he releases; that it presses on his feet to give him the sensation of weight, etc. It displays all the effects which he would expect if it were at rest in a gravitational field. On the other hand, if it were falling freely under gravitational influence, its occupant would sense no weight, objects released would not leave his hand, the reaction from his every motion would change his every position in his cage, and he could equally well assume himself at rest in a region of space free from gravitational action. Accelerated motion may *always* be interpreted, by the observer on the system, as ordinary force effects on his moving system, or as gravitational effects on his system at rest.

An alternative statement of the Special Theory is that the observed phenomena of uniform motion may equally be accounted for by supposing the object in motion and the observer with his reference frame at rest, or vice versa. We may similarly state the General Theory: The observed phenomena of uniformly *accelerated* motion may in every case be explained on a basis of stationary observer and accelerated objective, or of stationary objective with the observer and his reference system in accelerated motion. Gravitation is one of these phenomena. It follows that if the observer enjoy properly accelerated axes (in time-space, of course), the absolute character of the world about him must be such as to present to him the phenomenon of gravitation. It remains only to identify the sort of world, of which gravitation *as it is observed* would be a fundamental characteristic.

Euclid's and Newton's systems stand as first and second approximations to that world. The Special Relativity Theory constitutes a correction of Newton, presumably because it is a third approximation. We must seek in it those features which we may most hopefully carry along into the still more general case.

Newton's system retained the geometry of Euclid. But Minkowski's invariant expression tells us that Einstein has had to abandon this; for in Euclidean geometry of four dimensions the invariant takes the form:

$$\sqrt{(X-x)^2+(Y-y)^2+(Z-z)^2+(T-t)^2},$$

analogous to that of two and three dimensions. It is not the presence of the constant C in Minkowski's formula that counts; this is merely an adjustment so that we may measure space in miles and time in the unit that corresponds to a mile. It is the minus sign where Euclidean geometry demands a plus that makes Minkowski's continuum non-Euclidean.

The Einstein Editor has told us what this statement means (SCIENTIFIC AMERICAN, Sept. 18, 1920, "New Concepts of the past Century"; and Dec. 4, 1920, "That Parallel Postulate"). I think he has made it clear that when we speak of the geometry of the four-dimensional world, we must not read into this term the restrictions surrounding the kind of geometry we are best acquainted with—that of the three dimensional Euclidean continuum. So I need only point out that if we are to make a fourth (and we hope, final) approximation to the reality, its geometry must preserve the generality attained by that of the third step, if it goes no further. Einstein accordingly examined the possible non-Euclidean geometries of four dimensions, in search of one displaying fundamental characteristics which, interpreted in terms of space-time, would lead to the observed facts of gravitation. The mathematics of this investigation is that part of his work which, we are told, but twelve men can follow; so we may only outline his conclusions.

Einstein's Time-Space World

If we assume that in the neighborhood of matter, the world of space-time is non-Euclidean, and that its curvature or distortion or non-Euclideanism is of a certain

(Continued on page 155)

Correspondence

The editors are not responsible for statements made in the correspondence column. Anonymous communications cannot be considered, but the names of correspondents will be withheld when so desired.

The Gravitational Function

To the Editor of the SCIENTIFIC AMERICAN:

In your issue of July 24, 1920, under "Notes and Queries," replying to G. S. DeH., who asks, "Is gravity strongest at sea-level or does it increase as one nears the center of the earth?" you make the statement, "Gravity is greatest at the earth's surface and diminishes as one goes either above or below the earth's surface."

It strikes me that this is a serious though rather common misconception of the truth. S. E. Coleman in his text-book, "Elements of Physics," published in 1906, makes a similar mistake, which he admitted only when confronted with the mathematical proof of the error.

His statement and yours above quoted would be true if the earth were a sphere of *uniform density* throughout; but this is not the case at all, the average density being about 5.56 while the extensive outward "shell" reaches only about half that figure. This would force the interior portion to have a density of perhaps twice the average.

Now as we pass within the body of the earth the "shell" penetrated does not exert a backward (upward) pull, but, as is well known, is neutral. We are, however, approaching the denser interior sphere, with a consequent increase in its gravitational effect; and this, for a distance, more than compensates for the neutralization of the attraction of the lighter exterior "shell" passed through and consequently gravity is meantime increasing instead of growing less as is often carelessly assumed.

If we assume a *constant* increase of density from the surface to the center of the earth, which is probably about correct, it will turn out that gravity instead of being "greatest at the earth's surface" will be greatest at a depth of about 600 miles—and 600 miles is about 15 per cent of the earth's radius!

If my reasoning is not approximately correct I should be glad to see a discussion of the case.

Forsyth, Georgia. WADE HAMPTON STEMPLE.

A Protest from North Dakota

To the Editor of the SCIENTIFIC AMERICAN:

When I first commenced to read your paper more than thirty-two years ago, I though it to be a substantial paper, and so I believe it is in the present age, as a rule, only I have to denounce the Einstein Editor as more so unfair, than fair to the reader.

Maddock, N. Dak. OLAF H. FOSS.

An Anticipation of the All-metal Airplane

To the Editor of the SCIENTIFIC AMERICAN:

Some eight or ten years ago you published drawings and detailed description of an all-metal monoplane. As I remember, the finished picture of this machine was on the front cover of the SCIENTIFIC AMERICAN and detailed drawings were on the inside. I cannot remember even the year in which this appeared; but it was before the World War—probably about 1908. In my estimation the idea was so far ahead of the times that it would be very desirable to reprint the whole article. At any rate—if at all possible to supply me with a copy —I will be very grateful. There were no wires on the outside; the wing spread was about 50 feet, but the wings were very narrow—and a speed of 150 miles per hour was predicted—all of which we have now—with the exception that the machine you displayed had finer lines. J. RUSSELL JONES.

Tacoma, Wash.

[*The article referred to was published in the* SCIENTIFIC AMERICAN *of Oct. 22, 1910, and was republished in our issue of Aug. 14, 1920.*—EDITOR.]

Paper from Corn Husks

To the Editor of the SCIENTIFIC AMERICAN:

Before wood pulp became the main reliance for paper stock attention had been called to corn husks, which were found to make excellent paper. The fiber is very strong. It is true of the husk only, not the stalk or leaves, and is the part not valuable for feed when dry.

The corn crop now reaches three billion bushels, and for every bushel there must be several pounds of husks. Paper stock of spruce, poplar and other woods has become so costly as to make the substitution of husks possibly a profitable operation for the farmer, especially in the great corn growing states. The husking season, as with the grain itself, may be a matter of weeks or months, and the material deteriorates but little from exposure to weather, as the husks shed rain or dry quickly, and they are now a waste product. At only one pound of husks to the bushel of corn, a billion bushels would yield half a million tons of husks, and five pounds per bushel would be a low estimate or two and one-half million tons. Thrice that, if all could be utilized, would make a very material addition to paper stock. There is also the possibility of valuable by-products in the process of manufacture, as is the case with the coking of coal.

In order that the editor may see for himself how lavishly Nature provides a wrapper for one of the most valuable crops, and how tough and fibrous it is, I am sending to him by parcel post herewith two ears of corn unhusked, though not fully dry. The possibilities of such an abundant supply of an annual crop seem almost boundless. GEO. S. PAINE.

Waterville, Me.

Sunspots and Terrestrial Temperature

To the Editor of the SCIENTIFIC AMERICAN:

During the past fifteen years the question of the fluctuation of solar radiations has been critically investigated. It has been determined that the spotted areas of the sun have a lower temperature than the general photospheric surface. Guided by this fact, Koppen, Newcomb, Abbot and Fowle and others have shown that the average surface temperature of the earth is slightly less during the maximum of the sunspot period than it is during the minimum phase of that period. At present the spot period is running to minimum and for several months the sun has been almost free from spots. The climatic effects of this periodicity of the output of solar radiation should justify the attention of meteorologists and result in studies of practical use.

Baltimore, Md. W. E. GLANVILLE.

Left: Chief electrician of the Lasky studio with two of the spot lights used for unusual lighting effects. The light at his right has the switch on the standard, while the one at his left is of an improved model, with the switch on the light head. *Center:* How the spot light is employed for "back lighting"—an effect which causes the actors to stand out from the background and which makes for a sense of relief. *Right:* Operating a pair of overhead spot lights which are being played on the principals in an elaborate scene

Motion picture spot lights and how they are used to produce beautiful screen effects in our present photoplays

Film Lighting as a Fine Art

Explaining Why the Fireplace Glows and Why Film Stars Wear Halos

By Frederick S. Mills

Electrical Illuminating Engineer at the Lasky Studio, Hollywood, Calif.

An important phase of motion picture production is the system of illumination. Such terms as "Klieglights," "Sun Arc" and "Spots" are becoming familiar expressions, even to people who have never been within thousands of miles of a motion picture plant, and who have no technical knowledge of electricity.

A common question among "movie" goers is why artificial illumination is at all necessary—why the scenes cannot be photographed in the sunlight? This is not such a foolish question as it might at first appear, because in the early days of motion pictures very little artificial lighting was used, most of the scenes being photographed in natural daylight. But, in the first place, it will be seen that merely by the use of sunlight, no special effects, so important to the motion picture in its present advanced stage of artistic development, could be obtained. In the second place, it must be understood that even on a clear day, light values do not remain, throughout the day, at the same intensity.

At noon, perhaps, the light is very bright, but as the day begins to wane, say along about three or four o'clock in the afternoon, although it is not so perceptible to the eye, the value of the light, photographically, is very much lower. It may so happen that a scene photographed at twelve o'clock and one photographed toward the end of the day, will appear consecutively in the completed film. The one would be bright and clear; the other a little darker in tone. The first might be a "close-up" of a player, and the next a longer "shot" of the same player. The result would be a confusing effect as the two scenes were fla hed on the screen—and one far from artistic or agreeable to the eyes. This, of course, applies only to interior scenes.

Thus, as the industry has progressed, it has come about that to secure even, unaltered light all the way through the interior scenes, except where the light is purposely altered to secure effects, artificial lights are used almost entirely in American studios. Even when the scene is taken in a setting which is out on an open stage, a battery of artificial lights is used to insure a regularity in lighting, despite the time of day.

"Klieglights," the big lights with double carbon arcs, which are generally diffused with ribbon glass or a semi-opaque curtain to break the sharpness of the light, are used for general illumination, or as a prime flat light to illuminate the entire setting or scene.

The use of spotlights, which are small lights with single carbon arcs and condensers, is more involved. The most common use of the spotlight is for backlighting. By focusing a spotlight on the back of the heads of the principals, the image or images are caused to stand out from the background and the figures are more pronounced and thus better depth is obtained. If this were not done, the figures would go dead against the background, no matter how far out they stood in the perspective. Sometimes the error is made of putting too intense a spotlight on the hair of the player. This forms a sort of halo.

Different types require different intensities of light for the back lighting, and a study must be made of this relation before ideal results can be obtained. For instance, a blond does not require such an intense light as a brunette. These various degrees of intensity are obtained by regulating the size of the beam of light and by the use of a diffuser which fits in front of the condenser, or lens, and is known as a "frost" because it is made of "frost" paper. This "frost" tones down the sharpness and intensity of the light and makes it softer.

Spotlights are also used for what is known as cross-lighting. For this purpose, the spotlight is placed so that it might throw a beam of light across the face of the player. This is for the purpose of destroying the effect of certain facial lines or expressions producing shadows, or shadows from the nose, chin, or other features. In the case of cross-lighting, another spotlight is often placed exactly opposite the first so as to counteract any shadows cast by the first. At times it is also necessary to place what is known as a "baby spot" on the floor and throw a beam of light up under the features of the player.

The relation of make-up to lighting must also be studied by the electricians and cameramen. A dark make-up requires a much more intense light than a lighter make-up; and when there are two persons in the scene, possibly a star and a leading player, if one has a dark make-up and the other a light, much care must be exercised in so regulating the light that it neither "burns up" the light make-up nor is of insufficient strength to light up the dark make-up. A happy medium must be struck in cases of this kind, so that all get equal benefit from the light value, as it is impossible to have a special light for each individual and attempt to keep it focused

(*Continued on page 157*)

Interior view of main studio floor of the Paramount studio in Long Island City, N. Y., showing the battery of mercury vapor lamps suspended from trolley rails on the ceiling

The Army School for Weather Observers

By George Gaulois

THOSE who read the army recruiting posters "Learn while you earn" may not realize what a wealth of choice the army offers to its learners. Weather forecasting? Yes, the army teaches that, too, as well as 107 other courses, in its new program of education and occupational training for soldiers who enlist. Camp Vail is one of the very few places in the world where a man can learn to be a meteorologist.

The class-room is a sunny, wind-swept platform. Here are the instruments for measuring the temperature and pressure of the air, the direction and force of the wind, the amount of rainfall, and the action of the invisible air-currents a mile from the ground. Readings are taken at exactly the same moment as in all the thirty-seven weather stations of the Signal Corps, widely separated throughout the country, and simultaneously with the readings of the numerous weather offices of the Department of Agriculture. Any variation of time between these readings makes part of them useless or involves a considerable amount of correction.

More than $200,000 has been expended on the meteorological apparatus at Camp Vail, and the course of instruction is being conducted by a highly-paid consulting engineer, Arthur A. Rausch, formerly with the Weather Bureau. He is assisted by a staff of non-commissioned experts, and they have the exclusive attention of their class during the six months; that is, no student is allowed to follow other studies in the school at the same time.

When he has completed the class-work at Camp Vail, a meteorological student may be stationed near Aberdeen, Md., where the Army heavy guns are tested. For since artillery has been developed until a projectile may travel ten or fifteen miles, weather conditions enter vitally into the result. It costs several hundred dollars to fire one of the enormous engines of war used by the coast defense, and no steps are spared to guarantee a hit on the target when the signal is given—"Fire!"

Several varying currents of air will be encountered by the shell in its flight. These will not be the same as the particular breeze at the firing point; moisture in the air on one day will cause a projectile to behave differently; heat and air-pressure will also affect the accuracy of the calculated course of the shell; so, to the normal calculations necessary to make half a ton or so of steel hit a target far out on the horizon, mathematical corrections are made for the special weather conditions of the day. These are based on information furnished by the Signal Corps.

Or, the student of weather may be assigned inland to one of the fifteen weather offices which help the Air Service. Aircraft have been so perfected that local weather conditions make little difference for short flights, but when a cross-country flight is contemplated, the pilots want to know in advance what sort of weather they are going to find. They get this information from the Signal Corps' weather sharps.

The separator that picks out vetch seed from that of the other grain grown in the same field

It is largely on the account of the Air Service that these observations are made, for they always include records of the weather at an altitude of 1,500 meters. This is not furnished by the weather bureau operating in the Department of Agriculture, except in about fifteen stations which were abandoned by the Army after the World War.

In return, the Army stations are provided with the weather bureau's records, as both services work hand in hand. It helps the accuracy of the weather bureau's predictions to know how the elements are behaving a mile up. When the Americans got to France, they found no such coördinated weather service as exists in this country, and the Signal Corps was forced to establish its own stations. No gas offensive measures of any size could be taken without reliable weather forecasts, except at great risk to our own troops.

Everyone who served in the trenches knows, of course, the tiny wind-vanes that were mounted along

(*Continued on page 158*)

Round Seeds and Mechanical Ingenuity

By S. R. Winters

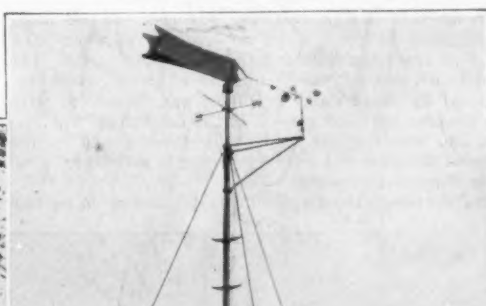
HAIRY vetch, the most widely grown of leguminous forage crops with the possible exception of sweet clover, usually forms companionship with grain in cultural practices. Not unlike the Biblical parable of separating the wheat from the chaff, the hairy vetch seed must be divorced from other grain in order to obtain a commercial seed supply. Ordinary seed separators are inadequate; consequently, there is on the market a simple but ingenious device which is described by the Bureau of Plant Industry of the United States Department of Agriculture as the keystone of the hairy-vetch seed industry.

Devoid of moving parts, this separator functions by gravity and centrifugal force, the seed being fed into a hopper at the top of the machine and follows the devious course which winds like the thread of a screw. The mechanism consists of three or more spiral chutes having a common center mounted on a vertical column, the outer chute being larger than the others and fitted with a vertical rim. The mixture of vetch and other grain, which was a companion crop in farming practices, is fed into the hopper, whence it is distributed equally to each of the small spirals. Remove a slide and the conglomeration of seed whirls down through these spirals at a rate that would be considered as exceeding the speed limit if traveling on the National highways. Only a few brief seconds intervene between the entrance of the seed at the top of the machine and their exit at the bottom.

Fortunately, Nature came to the rescue of latent mechanical ingenuity. Hairy-vetch seed are round and smooth in formation while oats, rye, and other grains are flat-sided or oblong. This machine capitalizes this essential distinction. The hairy-vetch seed roll swiftly to the outsides of the spiral where they bridge an edge or chasm and fall into the spacious outside spiral. Seed not thus shaped do not glide so readily, but cling to the center of the spirals and are discharged from a central spout at the base of the device. Healthy hairy-vetch seed are estranged from the faulty ones by a vertical partition situated at the base of the large spiral. A spiral separator has a daily capacity of divorcing from 25 to 80 bushles of mixed seed.

Making Porous Bricks of Slag

THE slag which is a by-product in foundries has long been used both in making bricks and in cement, but a new method of employing it has recently been devised in Germany. According to *Stahl und Eisen* this consists in the production of extremely light bricks, resembling pumice stone in weight and appearance and employed mainly for building inside walls. The slag employed in making these bricks is passed horizontally in a molten form through water, the steam which arises mingles intimately with the jet of molten slag and thus produces, in escaping, an artificial pumice stone, in what is probably the same manner that natural pumice is formed.



Photos by photographic class, Camp Vail

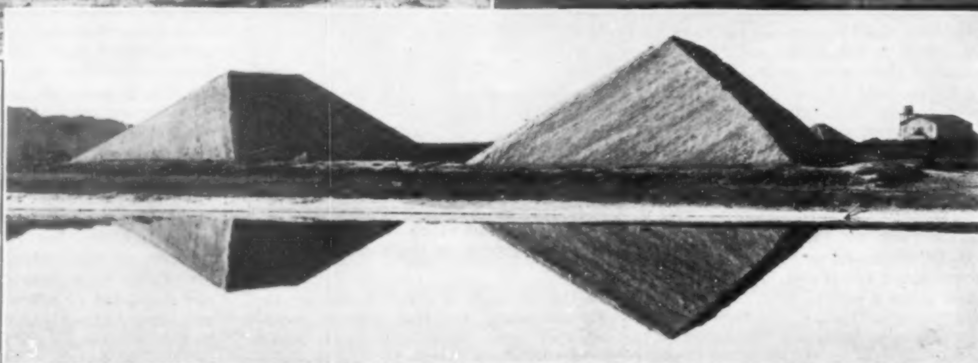
Left: Getting the weather by 'phone. Signalmen follow the meteorologists and fix their instruments to any handy tree. *Center:* The Camp Vail establishment where a soldier learns to be a weather sharp. *Right:* Meteorological class at the Signal Corps school sending up a balloon to get the wind direction at one-mile elevation

How the Army teaches weather observing to those of its men who wish to learn

Salt from the Sea

Some Details of a Little Known California Industry

By Arthur L. Dahl



1. Harvesting ocean salt in California. 2. Piling the raw salt from ocean water to dry at San Francisco Bay plant. 3. Salt pyramids piled for drying on San Francisco Bay

How salt is recovered from the waters of the Pacific

SALT is one of our food requisites, and though a little bit goes a long way in seasoning what we eat, we miss its presence as much as any other ingredient. Stock will travel for many miles to reach a "salt lick," and the judicious use of salt is one of the methods employed by stock men to guide and control the movements of cattle on the big Western ranges.

In addition to its use for culinary and food purposes, salt is largely employed in the meat-packing, fish-curing, ice-cream making and other industries to preserve food from deterioration. It enters into the refrigeration process, and it is employed in the chlorination of gold and other metals. Salt helps to form a glaze on pottery, and it is used in enameling and pipe works, and for curing hides. Many chemical industries use salt brine in the preparation of chemicals having a soda base, such as soda ash, and caustic soda. Altogether, salt has many uses, and the United States annually consumes more than 50,000,000 barrels.

No country in the world has more abundant or more widely distributed salt resources than the United States, for salt is found, in some form, in all parts of the country, and the supply seems inexhaustible. Many of our salt deposits, and reservoirs of brines, are undeveloped for want of markets, as our domestic demands and a constantly growing export trade is easily supplied from the salt works already in operation, and most of these can be greatly expanded if the occasion requires.

Our salt supplies come from three different sources—the mining of rock salt in such states as Michigan, Ohio, Kansas, and others, the making of salt from natural brines pumped from below the surface in the same and many other Eastern and Central States, from the evaporation of ocean water on the Pacific Coast, and at Syracuse, N. Y. Since the average value per barrel of all salt marketed in this country is in the neighborhood of forty cents, it is apparent that any method used in its manufacture must be exceedingly economical to be successful. For this reason many large and excellent deposits of salt remain undeveloped because the competition from existing salt works is too keen.

On the coast of California there has been developed in recent years quite an extensive industry in the manufacture of ordinary salt, or sodium chloride, from sea water. California ranks fifth in salt production, practically all of which comes from the sea. Aside from the salt works on Great Salt Lake, in Utah, and at Syracuse, N. Y., practically the only solar salt plants in the United States are in California. On San Francisco Bay there are numbers of these solar plants, and others operate in southern California, near Long Beach and San Diego.

Ocean water contains, on an average, 3.77 per cent of salt, although the salinity of ocean water varies in different localities, owing to evaporation and other causes. For instance, the waters of the Pacific in the vicinity of San Diego contain an average of 4 per cent of salt, while that farther north is less.

In the manufacture of salt by the solar process natural forces are utilized wherever possible, for it is only by this means that the business can be made profitable. At each plant an average of over 1,000 acres of low-lying land is utilized as salt ponds. The land is divided off into a number of ponds, each surrounded by earth dams or dikes, and connected with one another by flood gates. If the conditions will permit, the water is let into the various ponds by the force of the tide, and where pumping is necessary, wind mills furnish the power.

The center of the California salt industry is on San Francisco Bay, where salt works occur on both the Alameda and San Mateo sides of the bay, and the refined salt from these plants is said to be equal to any found on the American market. Here the salt-making season extends from about the middle of May to the middle of September, or even longer, depending upon the length of the "dry season." Since practically no rains fall in California during the summer months, and the days are sunny and warm, the evaporation of ocean water can be carried on with great regularity and precision. While the waters of San Francisco Bay are less salty than the ocean, owing to the discharge of the Sacramento and San Joaquin Rivers therein, yet the absence of fogs and the adaptability of the marsh lands of the bay overcome this handicap, and after the first of July the discharge of fresh water into the bay materially decreases, and the maximum salinity is secured.

At the solar salt plants the various ponds are known as storage, intake, receiving or tide ponds into which the salt water is received from the bay, the concentrating ponds, and the crystallizing ponds. The ponds between the tide ponds and the crystallizing ponds are known as secondary or pickling ponds.

The sea water enters the works through a canal or slough which connects with the receiving ponds, provided with flood gates that open and close automatically as the tide ebbs and flows. In some plants, such as at Long Beach, new ocean water is being added to the plant constantly, but most of the bay plants introduce new water only at high tide, and store the water needed for the evaporating ponds.

The sea water is run from one pond to another and allowed to remain in each for a given period, until gradually the water becomes more and more saline and this concentrated water is then let into the crystallizing ponds when crystals of salt have begun to form. At some plants when the pickle in the salt ponds has reached a strength of 29 degrees B., the bittern with some salt in it is run into other ponds, where it evaporates until a concentration of 32 degrees B. is reached, when the mother liquid is allowed to go to waste.

On a general average, a plant will provide about ten evaporating ponds for one crystallizing pond, and during the salt season it is the aim of the management to keep all parts of the plant running in unison, so that a maximum of salt can be har-

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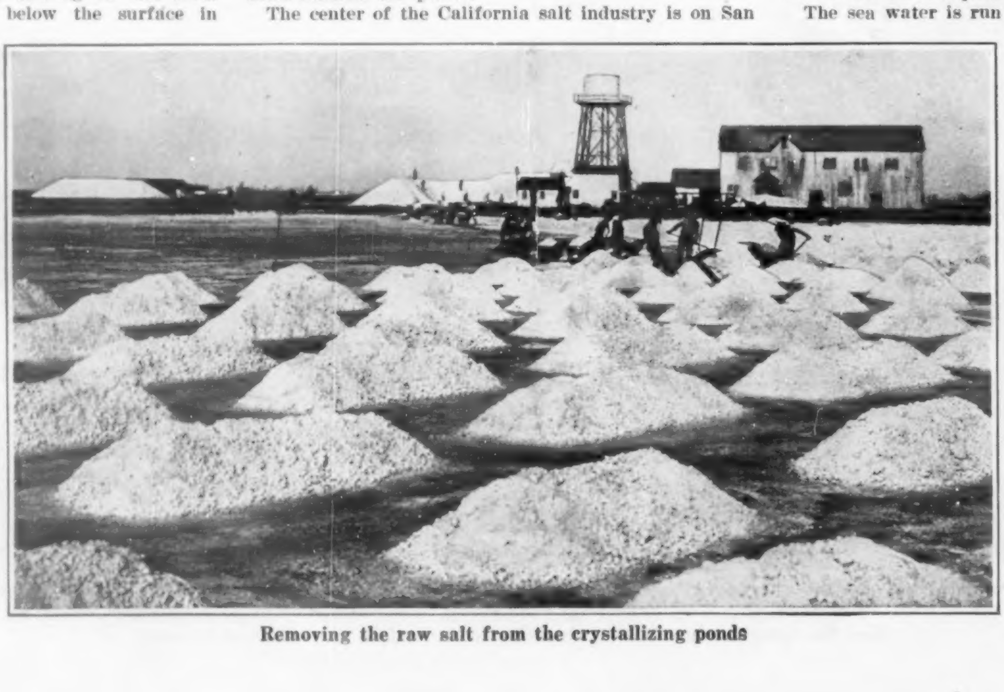


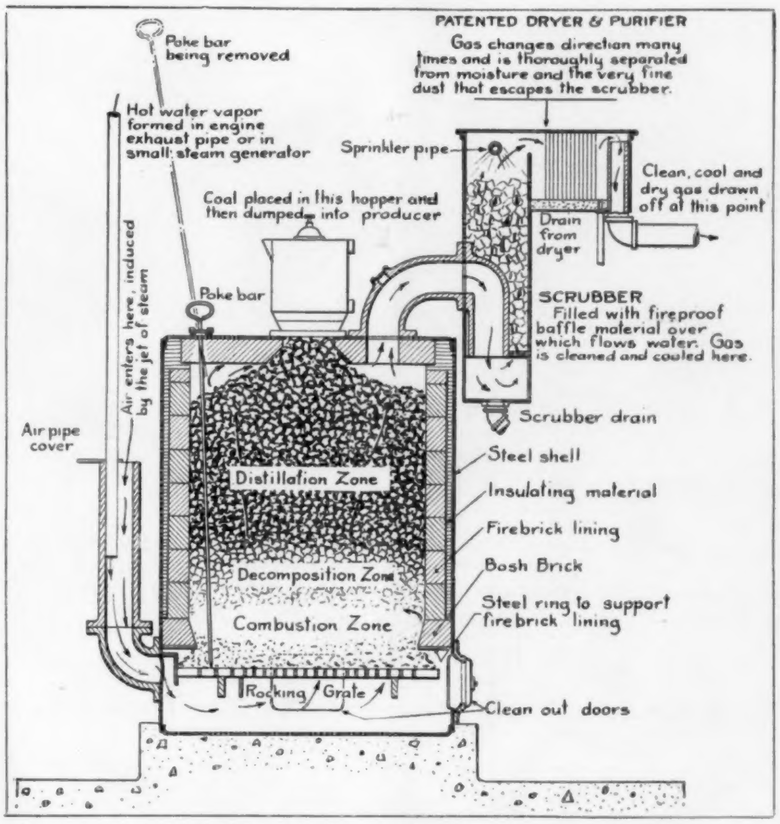
Removing the raw salt from the crystallizing ponds

Solid Fuel for the Gas Engine

By Ralph Howard

THE world-wide shortage of fuels, and their constantly increasing cost, makes imperative their most efficient use. Not so many years ago, if a man insisted on burning in his power plant a fuel which had to be shipped to him from an excessive distance, or which was obtainable only at excessive cost, or which was usable for his purposes only at excessive inefficiency, it was nobody's business save his own. Today it is as much the business of the fuel producer and of the man who could use the fuel more cheaply and develop more effective heat units from it, as it is the business of the prodigal himself. So much is this the case that a prominent authority on fuel conservation recently stated that the time is not far distant when the use of raw coal in the usual fire-box, with its attendant poor economy and generation of destructive gases, will no longer be permitted.

One way of avoiding this is to be found in the use of the gas producer. This is in its bare essentials a device for the conversion of solid fuel into a gas suitable for use in an internal-combustion engine. On the face of this statement, it would appear that, theoretically at least, the producer might with some hope be looked to for a combination of all the advantages of solid-fuel handling with all those of the internal-combustion engine. Practically the gas producers heretofore available have not realized this expectation; and on this account the mention of the gas producer does not carry with it, to those who ought to know, the impression that we are talking of something that has scored an assured success. But the producer, like everything else, is in a constant state of attempted improvement; and on the basis of its latest and best performance it ought to be recognized as a thoroughly efficient means of power generation.



Diagramatic cross-section of the latest style gas producer, showing the various parts and indicating their functions

The gas producer is not in its general outlines a complicated mechanism. It consists of a steel shell, as shown in the figure, lined with fire brick and fitted with grates at the bottom, within a closed ash-pit. The coal is fed into this shell through a specially constructed hopper at the top, which keeps the air away from the surface of the fuel bed. Connected to the top of the producer by means of a large gas pipe is a scrubber, filled with coke or crushed stone, over which water is sprayed for cleaning and cooling the gas; and final cleaning is effected by drawing the gas at high velocity through a series of baffle plates. At the other end of this line, of course, is attached the intake manifold of the engine in which the gas is to be used.

Operation is simple. As the engine runs the vacuum created by the piston displacement draws air into the producer through properly designed intake valves, causing the coal to undergo a partial combustion with free formation of gas. This air is drawn through the burning fire bed, and with it a proportionate amount of steam is admitted. The function of the steam is to keep the ash from clinkering, and by its decomposition into oxygen and hydrogen to enrich the gas.

With the majority of the producers that have been offered heretofore, if not actually with them all, steam control has been the unsolved problem. Sudden changes in engine load have interfered with the supply of steam, or the steam supply has not been sufficiently flexible to respond to these changes immediately; the result has been that with every change in load the quantity or the quality of the gas supplied has suffered. But a producer lately placed on the market replaces the intricate and expensive steam controls which have been customary with a few simple parts that achieve their end with complete satisfaction. Steam is made for this producer in the engine exhaust. As the load increases, more gas is burned; more burned gas is exhausted, causing more pressure. This increased pressure in turn forces more steam into the producer,

(*Continued on page 159*)

Keeping Check on Factory Air

By Jacques Boyer

THE study of industrial atmospheres is one of the main tasks entrusted to expert toxicologists. They must particularly determine traces of noxious gases which infest all factories and which are mainly carbonic acid and carbon monoxide. In order to estimate with some precision the degree of pollution of confined air, it must be analyzed quickly, but up to the present laboratory apparatus at the disposal of hygienists was both unwieldy and difficult to transport. M. Kohn-Abrest, Director of the Toxicology Laboratory of the City of Paris, has facilitated the operations of his colleagues by bringing out a strong and simple apparatus permitting the making of quick analyses. The most simple and practical of the apparatus which he uses comprises a pail of zinc, with a capacity of about 5 liters, in which the air to be analyzed is drawn in by letting water flow through flat bottles, each one independent of the others. Metal tubes with faucets connect these receptacles, disposed in battery formation on the copper cover, which may be unscrewed in order to allow the pail to be filled. The speed of intake, determined by experiment, corresponds to 120 to 140 bubbles and a scale shows the volume of air aspired.

In a general way, the Kohn-Abrest apparatus comprises four bottles, and thanks to their detachableness and rubber connections, they can be used for the simultaneous comparison of several suspicious atmospheres. Two are sufficient, however, for ordinary purposes; with the first, the carbon dioxide and monoxide are admitted, while in the second, the presence of other noxious emanations is investigated.

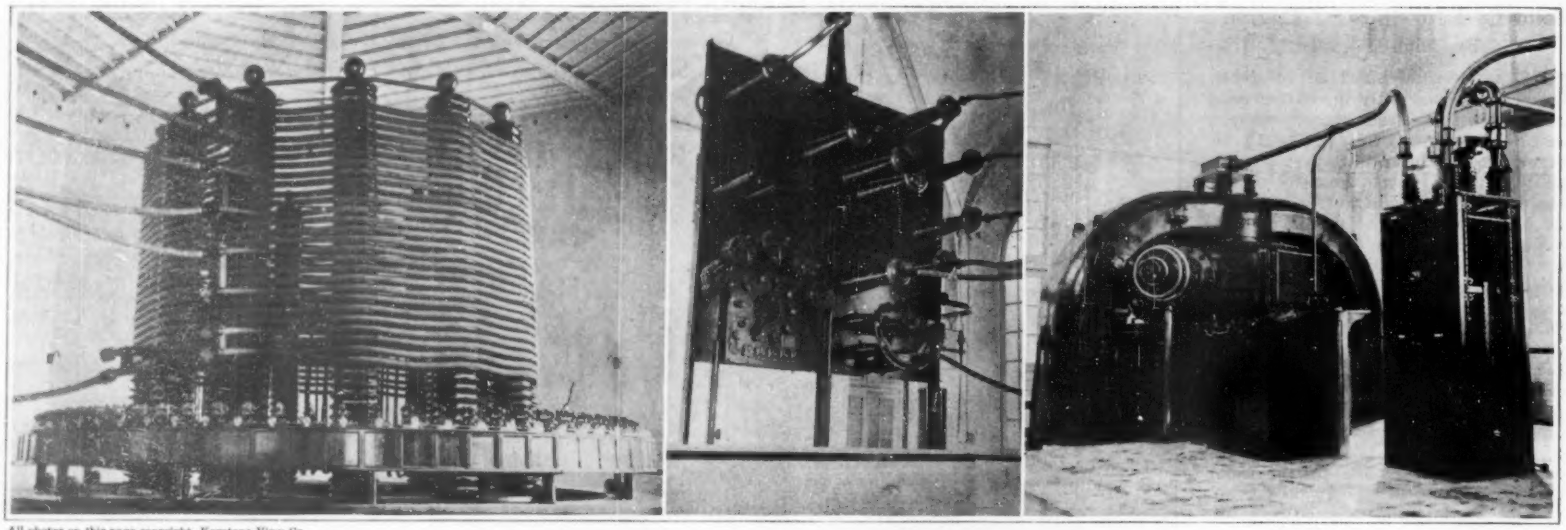
After a long series of experiments, M. Kohn-Abrest has found that "water of barium" put in a single washing bottle permits the total absorption of carbonic acid. Besides, as the carbonate of barium which is formed settles very quickly at the bottom of the vessel it is possible to dose, with a little practice, the carbonic acid as fast as it collects.

The simple estimate of a deposit of carbonate is sufficient to reveal to an experienced toxicologist the degree of variation of the atmosphere under study, and he thus avoids protracting the experiment without necessity; at an aspiration speed of two liters per hour, it is possible to stop the apparatus after one hour in case of an air showing 5 parts impurities in 10,000 (normal air), at the end of a half-hour in case of air 1 to 1,000 (confined air), and after a mere ten minutes in case of air of 4 to 1,000 (very unhealthy air). As for the analysis of the other acid gases, it can be done immediately, the initial alkalinity of the water of barium used is known; it is sufficient to subtract,

(*Continued on page 159*)

Left: The Ogier mercury "grisoumeter" for measuring the amount of fire-damp in the air. *Center:* Portable outfit of the industrial toxicologist. *Right:* The apparatus removed from the case and set up for work.

Rapid and accurate analysis of industrial atmospheres by a new French process



Left: Huge aerial inductance coil which varies the wave length of the aerial circuit. *Center:* Rear of panel which controls the wave length of the transmitter. *Right:* One of the powerful arc type generators with its control unit at the right

Some of the transmitting apparatus of the Lafayette radio station

Why Not Radio?

Some Technical Advances Which Have Made Wireless Commercially Practical

RELIABILITY is the very essence of commercial communication. To that must be added speed, in the case of telegraph, telephone and cable communication. And until wireless or radio communication proved that it was reliable and speedy, it could not serve in an everyday commercial way except in ship-to-ship and ship-to-shore traffic, in which fields it was alone.

One by one the technical advances in radio have been chronicled in these columns, hence it would be but repetition to describe them here. The Alexanderson alternator, the Goldschmidt alternator, the vacuum tube, the loop antenna, the arc generator, the photographic recorder and the phonographic recorder—these are but a few of the later-day devices which have made radio communication commercially practical. It is these devices which have made radio communication positive and reliable; no longer need transatlantic stations be held up for hours and even days by adverse atmospheric conditions, while messages pile up for transmission. Again, the speed of transmission has been tremendously increased, because reception has been made positive and reliable at corresponding speed. There was a time, true, when cables could handle a greater volume of traffic than the radio systems; but today the tables are turned and radio systems handle considerably more traffic. Thus the huge Paris station, which is now being constructed at Sainte Assise, France, will have a capacity equal to fifty ocean cables!

Tower of the main building with the lead-in cable from the antenna

A greater volume of traffic has obviously resulted in lower costs, particularly as regards overhead and investment charges; so it is not surprising to find the present radio tolls considerably lower than corresponding cable tolls. The press bureaus and newspapers were perhaps the first to appreciate the value of radio communication, but of late more and more business men have turned to this latest means.

An interesting case of radio service to business men is presented by the inter-city radio system recently opened to the public between New York, Detroit, Cleveland and Chicago, in more or less direct competition with the telegraph and telephone lines connecting those cities. The advantage of radio, in this case, is speed, for there is none of the delays sometimes experienced in the usual wire methods of communication. At the New York office, for example, two operators are at work, one receiving and the other transmitting. The office is located in the financial section, while the actual transmitting station is in the uptown section, some three miles away. The receiving loop is on Staten Island, some seven miles distant. The transmitting operator in the downtown office controls the uptown transmitter by means of a telegraph line and relay arrangement, while the receiving operator receives the incoming signals impinging on the loop aerial on Staten Island, over a telephone line. This dual operation permits of transmitting and receiving simultaneously, or two-way traffic at one time.

Dual operation is maintained with Detroit and Chicago and Cleveland. Messages can be 'phoned to the offices, where skilled 'phone girls take them down on a blank which is handed to the transmitting operator across the table. The incoming messages, on the other hand, are copied down on a noiseless typewriter by the receiving operator, and handed to the telephone operator who notifies the addressee. Of course, this telephone service is not new with this radio system, for it has been a feature of telegraph service for some years back. But the directness and simplicity of this radio system have much to recommend them, and it will be interesting to watch whether inter-city radio will spread to other localities.

The main aim of radio today, however, is in the direction of long-distance communication rather than the short jumps from one city to another. Hence the several stations of high power which are now handling transatlantic traffic, such as New Brunswick and Belmar, N. J., respectively, the transmitter and receiver units; Chatham and Marion, Mass., respectively, the transmitter and receiver units; Tuckerton and Belmar, N. J., respectively, the transmitter and receiver units. These stations are working with Nauen and Eilvese in Germany, Stavanger in Norway, Carnovan in Wales, and Paris, Bordeaux and Lyons in France. There are several other powerful radio stations in Europe intended for long-distance work, which may be pressed into commercial service in the not distant future, as the demand grows

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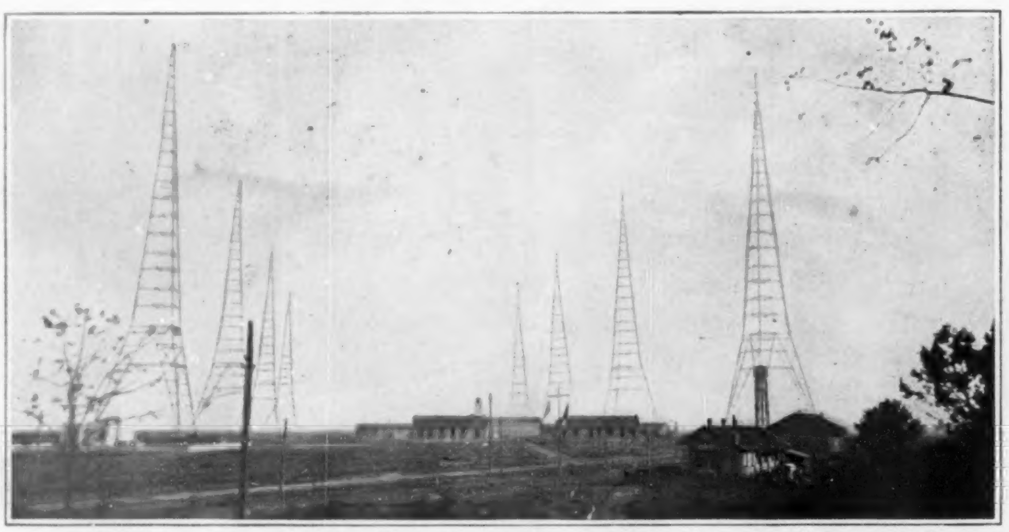


General view of the Lafayette radio station, showing the eight steel towers which support the antenna network and the station buildings

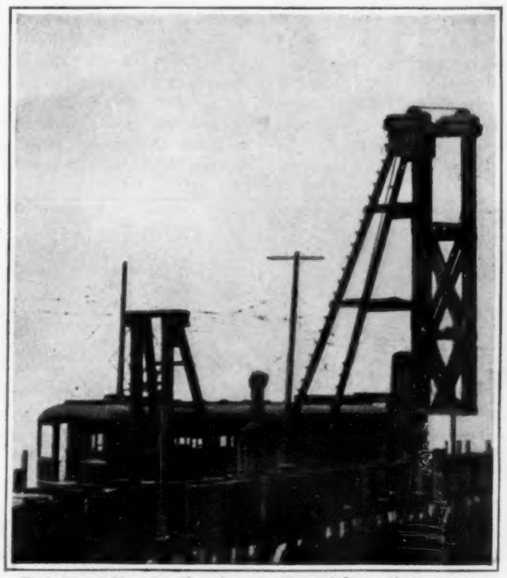
A New Job for the Clam-Shell Bucket

In excavating for the basement of a large motion picture theater in Vancouver a layer of tough sandstone was encountered. This was broken up in the usual fashion with dynamite and churn drills; but the removal of the resulting débris from the hole was accomplished in a decidedly novel fashion, as shown by our illustration. A contractor gifted with the precious quality of imagination was unable to see any good reason why the clam-shell grab-bucket could not deal with the situation, and sure enough it turned out to be quite capable of doing so. The clam shell, operated by a stiff-leg derrick and a donkey hoisting-engine, quickly lifted the stones and boulders from the blast, loading them direct into five-ton trucks. The big rock which figures in our picture we are told weighed about a ton, but as will be seen the bucket handles it without difficulty. A large amount of material was handled in this way at a minimum direct cost and at a great saving of time, the loading of a truck never consuming more than five minutes.—By *Theodore V. Berry.*

Loading the spoil from blasting with a clam-shell bucket

A Pile Driver for the Ferry Slip

The accompanying photograph shows a specially designed pile driver for driving piles in both the inside and outside row at the ferry slips at Oakland. An extension fastened to the pile driver carries the hammer out over the first row of piles for the purpose of driving the outside row, thereby making it unnecessary to drive this row with a pile driver carried on a barge and floating in the ferry slip. By this means the piles can be driven without interfering with the movement of the ferryboats in and out of the slips of Oakland, California.—By *C. W. Geiger.*



Driving piles in the ferry slip without interrupting the service

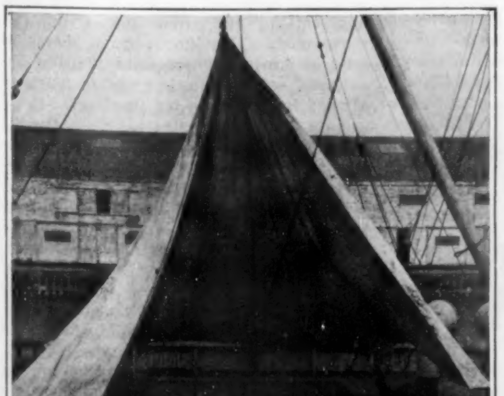
Speeding Up Snow Removal

Following the first heavy snow of the winter, a gang of fifty or sixty men for removing snow from the streets of Chicago was replaced by four men and the new snow loader shown on our cover this week. Besides successfully replacing so many men, the machine was able to load so quickly that a great reduction was possible in the number of trucks required. Four trucks, only, each being loaded in an average of five minutes, were needed where twelve were required before when most of their time was spent in waiting during loading.

No change had to be made in the usual scheme followed in removing the snow by hand. Plows attached to trucks placed the snow in the long windrows in the gutters. In place of swarming gangs of men shoveling into high trucks, came the loader filling the trucks to overflowing so quickly that side boards for the trucks to carry a greater load became imperative.

The machine is mounted on crawlers to gain the best traction. It is powered by a four-cylinder truck-type gasoline engine. A two-armed apron scoops up and turns the snow on to a wide cleated belt which carries it up to discharge into waiting motor trucks. This apron plow is adjustable. It is possible to scrape the surface clean or leave enough space to pass over any obstruction. Adjustment is made by the operator from his platform on the loader. Skirt boards twelve inches deep keep the largest lumps on the belt and give it an effective carrying width of thirty-six inches. The belt is positively driven, being fitted with roller chain on each edge.

Chicago city officials put the loader to work the day after Christmas to remove the snow on Michigan Boulevard. After working the downtown length of the Boulevard, the machine worked across into the loop district. It ran for thirty hours without a pause, being operated by three shifts of eight hours each. A minor repair was made and the machine continued. One of the things that recommended it most highly to the officials in charge was the fact that it would work just as hard and tirelessly between midnight and morning as at any other time. This is the time when men are least efficient if they will work at all.



Hatch tent for unloading in wet weather

Dry Stevedoring in Wet Weather

Vessels are not delayed during the rainy season if they are equipped with hatch tents, nor is the cargo subject to damage from loading and unloading in the rain. This clever use of a canvas or duck tent has saved time and money for various shipping concerns. Before the invention of these hatch tents a ship often had to lie idle until the storm blew over. With the tents stevedoring proceeds without much regard for the state of the weather. The tents are usually furnished in a size 32 feet square at the base and 35 feet from base to peak.—By *B. L. Butler.*

Cutting Metal with the Oxygen Flame

It is not for so very many years that we have known the possibility of cutting metals with the oxidizing flame. Even today, we do not have the clear insight into this process which we would have. There are many problems in connection with it that are not entirely clear, and some that are entirely vague. Many others are in a controversial state, the exact nature of what happens upon the application of the flame under various conditions are as yet awaiting determination. An interesting discussion of the state of present knowledge and the outstanding problems will be found in the Scientific American Monthly for February, under the title "Severing Metals by Oxidation."

The Ionic Dissociation Theory

Most really competent chemists are familiar with this theory in an offhand manner, but few have a thorough understanding of it. This is rather deplorable, for the theory is a potent weapon in the hands either of the student or the research worker. Mr. Albert T. Fellows, writing in the current number of the Scientific American Monthly for February, suggests a number of interesting and important experiments which are within the easy reach of the most elementary laboratory, and which should do much to render the ionic theory clearer than it has been.

Primitive Uses for Kelp

The importance of kelp in the economic life of the Indians of the Pacific coast is seldom properly estimated. A number of varieties are found in this part of the world which are suitable for human consumption, and which formed a material addition to the food stocks of these people. In addition, it was freely used as a bait in fishing for sea-urchins and other fish. *In situ* the kelp growths have probably saved a goodly number of Indians from drowning by providing a place of anchorage for a canoe caught out in a bad squall. Some of the larger varieties have stalks and bulbs which are useful as molds and even as bottles. The fabric of the stem makes an admirable fishing line. The seaweed serves nicely as chinking in the construction of houses. Its value as fertilizer was well known to the Indians. Likewise they were able to make considerable medicinal use of it. In short, as narrated in some detail in the Scientific American Monthly for February, the rich marine growths were of very great value to the savage races of the Puget Sound and California coasts.

A Battery That Is Different

A French inventor has recently put out a battery of novel design for which notable advantages are claimed. The superficial solution is poor in mineral salts and rich in ammonia, so whether used for continuous or interrupted service the battery never contains corrosive salts. The salts which are formed by long operation of the battery are deposited in the middle portion of the vessel, leaving the zinc as well as the surface of the liquid entirely clear; as a consequence the zinc is at all times fully utilized. The performance of the new battery is summarized in the claim that a cell mounted in a vessel 10 centimeters square and 22 centimeters high, containing one liter of water and 125 grams of salammoniac with a zinc plate weighing 160 grams yields a total energy either in continuous or interrupted service amounting to 125 ampere-hours. A full account of the battery appears in the Scientific American Monthly for February.

A Giant Among Conveyor Belts

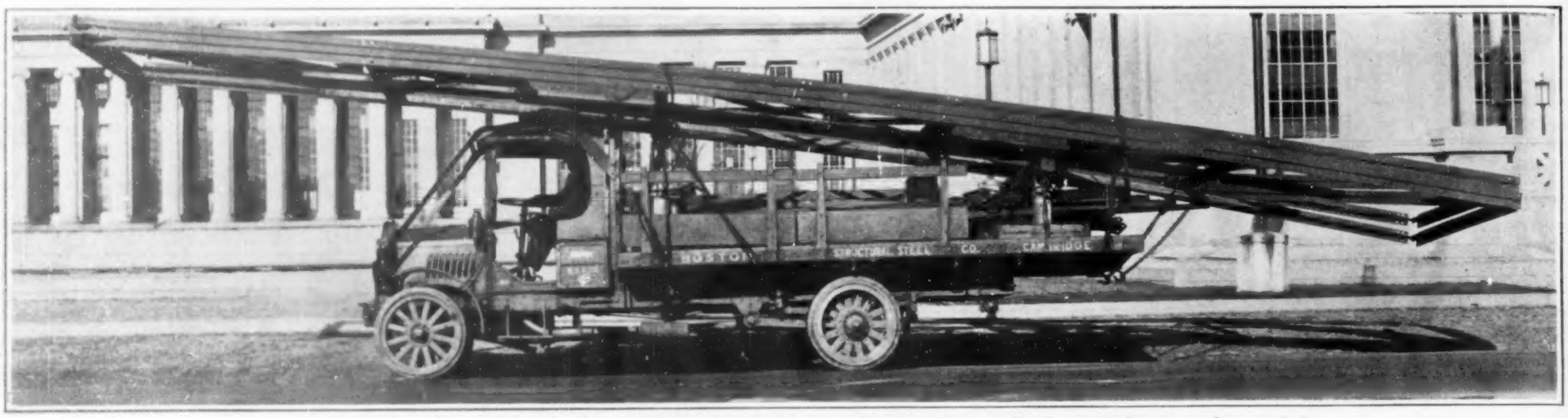
Two of the longest conveyor belts ever manufactured have just been made for the use of a big coal mine near Pittsburgh. Each belt is 48 inches wide, 1,050 feet long, and seven-ply. Each would make a strip of single fabric four feet wide and, if stretched to the maximum safe point, 14,700 feet long—or 2¾ miles. Over 5½ tons of surface stock were required in surfacing these huge belts, with their area of 58,800 square feet. And as seen in the picture, when rolled up ready for shipment each belt stood over eight feet high.—By *Lloyd Allerton.*

An acre and a third of conveyor belt

The Motor-Driven Commercial Vehicle

Conducted by MAJOR VICTOR W. PAGÉ, M. S. A. E.

This department is devoted to the interests of present and prospective owners of motor trucks and delivery wagons. The editor will endeavor to answer any question relating to mechanical features, operation and management of commercial motor vehicles



Truck equipped with special body for handling structural iron, showing how easily long girders may be carried

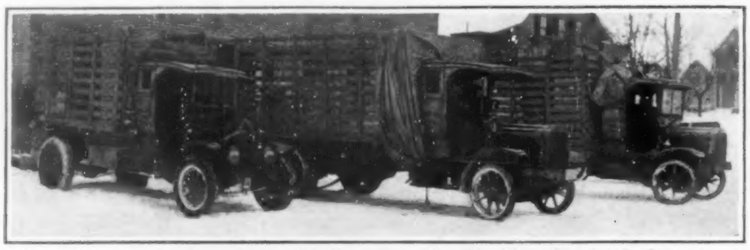
Moving Structural Steel

THE transportation of long heavy steel beams, pipes and girders has been a big problem for some time, and it has usually been solved by means of a semi-trailer or even a four-wheel trailer behind a motor truck. A Boston company has found a solution to this problem that is worthy of being described for the benefit of those who handle structural steel. The method permits the handling of long pieces by mounting a special frame work and body on a 3½-ton truck. The body, which is shown in the accompanying illustration, is 17 feet from the back of the cab and is 7½ feet wide. The frame of the body is built entirely of steel angles, having pockets to receive the stakes to which removable sides are attached. A piece of steel is attached to the front end, which is properly braced by having angle irons extend to the front end of the chassis. To this frame member is attached a frame work of angle iron extending across the radiator and approximately 18 inches wider each side than the width of the chassis. This frame receives the ends of long beams that overhang the body and makes it possible to haul structural members from 40 to 60 feet long without extending them over the top of the cab. This arrangement is very convenient for unloading at the destination because all the driver has to do is to take a crow bar and force the beam off of the frame and on to the ground. The frame work extending from the top of the cab makes it possible to haul steel trusses and girders from 40 to 80 feet long. A derrick arrangement for loading the truck makes it possible to load giant girders without much trouble. Any contractor handling bulky and unwieldy products such as long pipes, rails, built-up girders and columns will find the arrangement illustrated very practical and one that will give great satisfaction in handling an unwieldy load.

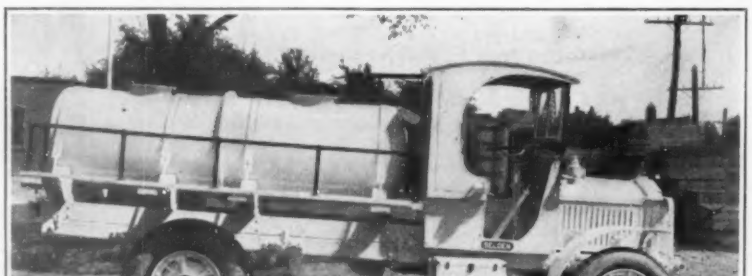
Tank Body for Milk Transport

MOTOR trucks have long been used for the transportation of milk in cans or bottles and have made many creameries and dairies practically independent of railroad schedules besides tapping new sources of supply. But the milk has been handled in cans which have an average life of four years, cost about $6.50 each, and cause considerable expense for cleaning and even loss of milk in spite of careful drainage. New glass-lined tank bodies that have recently been adapted to milk transport prove to be the most economical method of transporting milk by motor truck under certain conditions where their use proves to be profitable. The tank's strongest claim rests on its ability to save labor in the creamery and receiving station. In loading the truck the force of gravity will cause the milk to flow from the storage vats into the tank. With cans several men are needed to load the truck. When the tank of milk arrives at its destination, either the force of gravity or suction will force the milk out of the tank, whereas cans would require several men to unload. The tank can be flushed clean in a very short time by one man whereas each can must be handled individually and considerably more time is required for cleaning.

The temperature increase of pre-cooled milk has been found not to exceed a degree per hour even on the hottest day without taking any special precautions to insulate the tank. This means that a haul of 100 miles would only result in an increase of temperature of a few degrees by the time the milk had arrived at its destination. Of course, these tanks are not profitable in all phases of milk haulage because the wholesale delivery of milk to stores, hotels, and other large consumers is only practical with cans, whereas retail delivery is now done for the most part by using bottles as containers for the small amount of milk used by the housewife. Wherever a large amount of milk must be transported from one point to another, the tank, which is glass lined and without a seam, is far more efficient and economical. For example, many city dairies have small collecting stations at certain points. The cans of milk are brought to the station by farmers or by truck lines operated by the dairy. The milk is emptied into large vats and thoroughly cooled before it is ready for transportation to the city via the glass-lined tank equipped truck. The tank capacity on a 2½-ton chassis is 500 gallons. It is 36 inches inside diameter and 118 inches long. It will carry 4,150 pounds of milk. Three and one-half-ton trucks carry a tank of 800 gallons capacity. This is 42 inches inside diameter and has an over-all length of 138 inches. This tank carries 6,640 pounds of milk. The 5-ton truck chassis is fitted with a tank 54 inches in diameter and 144 inches long. This has a capacity for 1,165 gallons which is nearly 5 tons of milk. The capacity is increased by the use of platforms furnished with guard rails which provide space for a number of cans. The milk is loaded in the tank at the top opening. The valve at the rear permits complete draining of the contents in a very short time. Not only milk but any beverage may be economically carried in a tank wagon of this design.



Fleet of trucks that connects the factories of a big New England shoe manufacturer, at great saving of time and money



Glass-lined steel tank-body for motor transport of milk

The Motor Truck and the Shoe Factory

BIG savings in transportation costs, effected by the use of motor trucks, with corresponding savings in time by the elimination of delays in the shipping of goods are becoming more and more pronounced as manufacturers and others dependent upon efficient transportation systems for business success continue to increase their truck installations. They have found that the motor truck affords an independent transportation service dependent in no way on agencies outside their own organization—a condition that not infrequently is of inestimable value to the shipper when goods must be moved quickly. Such a service, providing the proper truck equipment has been installed, is always at the beck and call of the truck owner for the movement of freight either short or long distances. There is no waiting for railroad cars. The dependable truck is always in readiness for the haul.

As a concrete illustration that demonstrates conclusively that the high-grade truck is a money-saver, a time-saver and a business-getter, may be recited the experience of a firm of shoe manufacturers of Brockton, Mass. Companies confronted by similar transportation problems can profit by studying the hauling methods employed by this company, which operates and controls nine factories with a total capacity of 24,000 pairs of shoes daily. One of these plants is in South Boston and another is in East Weymouth, Mass., each 20 to 25 miles from the parent factory at Brockton. A third is in North Adams, Mass., 160 miles to the northwest. Each factory performs a special function in the operation of the whole, making neces-

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Shipping Coal by Wire

(*Continued from page 144*)

pany is incidentally obtaining fuel; and geological conditions, as already explained, render the superposed stream a negligible menace. At the same time, the nearness of the coal field virtually eliminates freight costs. It has been estimated by the engineers interested that this factor alone will save annually, at present transportation rates, not less than $420,000 for each 100,000 kilowatts of capacity. There is reason to believe that the other mines in the vicinity will cease to yield in the course of the next quarter of a century, and consumers not so favored as the Springdale Station, will have to go farther for their coal and pay more for it.

The successful running of a commercial power plant of this kind is contingent upon an uninterrupted supply of coal at a fairly stable cost; and it is equally important to efficient results that the fuel be of a good and uniform grade. In the present instance the mine will yield not only coal of one grade but this will be of a superior quality. Therefore, it can be confidently predicted that the plant may be counted upon to get the most out of its splendid equipment and to turn out a kilowatt-hour of energy for less than two pounds of coal. As may be realized, Springdale lies within the great coal-producing area of the western section of Pennsylvania; and in that region there are hundreds of mines requiring purchasable power service. An idea of the nature of this demand can be gathered from the fact that a group of something like thirty-five mines has a monthly consumption of 2,800,000 kilowatt-hours! In the tributary Pittsburgh district there are steel plants that use large blocks of electrical energy, and these patrons, with their divers needs, can be supplied from this great station without the movement of a single ton of coal upon the railroads in the vicinity—at least so far as furnishing power for operative machinery.

This example of engineering advance and of the economic gains flowing from strategically located central stations serves admirably to emphasize the benefits to be realized on a wider scale through the interlinking of many power plants of a kindred character.

A Rural School Museum

(*Continued from page 145*)

Specimens should be kept in a case and properly labeled with small strips of paper. Specimens of stones, skeletons of birds and animals, not known, should be sent, to the State University, or some other institution for identification.

A case for the collection can be made by the pupils at a small expense. The lumber which should be pine or poplar and free from knots or windshakes can usually be procured at the local sawmill. A case four feet long, one foot wide, and five feet high would not be too large for a rural school. It could have four shelves, allowing sixteen inches at the bottom for the larger specimens and ten inches between shelves for those of smaller size. The back can be made solid if so desired. At the front and center a piece two inches wide extending from the top to the bottom, should be nailed. Two doors swinging from the ends of the case can close at this piece. Glass of suitable size for the doors can be procured at the hardware store. This can be placed in a groove on the inside frame-work and made secure with putty. A collection such as described would be prized by the community since it concerns all its people.

The New Concepts of Time and Space

(*Continued from page 146*)

type already known to mathematicians; that the curvature of this world in the neighborhood of matter increases with the mass, and decreases as the distance from

(*Continued on page 157*)

Testing Hack Saws

Every Hack Saw test has two distinct objectives. The first point to be determined is, what make of blade shall be selected as most efficient for the work of the shop as a whole. The second point, which is no less important, is—what particular blade made by the manufacturer whose brand has been selected, is best adapted to the conditions governing any particular piece of work.

The difficulties in the way of making sufficiently exhaustive tests to determine the all-round efficiency of various makes of saws has already been mentioned. To reach conclusions that are beyond doubt, every factor must be taken into consideration—the composition, temper, pitch of teeth, "set," gage, depth, and cost of the blade, the tension, pressure, speed and lubrication, and the characteristics of the material cut. As it is a fundamental in comparative tests that only one variable should be changed at a time, the magnitude of the task of making complete comparisons is manifest. The influence exerted by a variance in the composition and temper of the blade and the pitch and "set" of the teeth has already been indicated: these are factors beyond the control of the user of the saw.

Effect of Difference in Gage

The gage of the blade, another of the elements determined by the maker, directly affects the cutting speed. Tests have shown that if two saws differing only in gage are used to cut the same metal, the first few cuts are usually made by both blades in the same time, but about the fifth or seventh cut, the thinner saw will be found to be cutting faster. This is, of course, assuming that both saws are, except for the matter of gage, equally well adapted to use on that particular kind or shape of metal. The first half dozen or so cuts remove the extreme sharpness of the teeth and permit the element of "contact area" to come into play. Obviously, the thicker gage of one saw simply means more friction to be overcome and necessitates greater pressure to make the teeth cut. To make a 14-gage saw cut as fast as one of 20-gage, throughout a long series of cuts on the same material, probably double the amount of weight would have to be put on the thicker blade toward the last of the test.

In selecting a saw to use on any particular job, it is worth while remembering that a short blade, though of lighter gage, is stiffer in proportion, and consequently can carry a coarser tooth.—From *Hack Saws and Their Use*, published by The L. S. Starrett Co., Athol, Mass., for free distribution.

Recently Patented Inventions

Brief Descriptions of Recently Patented Mechanical and Electrical Devices, Tools, Farm Implements, Etc.

Pertaining to Aeronautics

METAL CONSTRUCTION.—D. J. MOONEY and D. H. EMBY, c/o Steel Wing Co., 48a Gillingham St., London S. W., England. An object of the invention is to provide a spar, longeron, or like devise for airship construction which is composed of relatively thin sheet plates secured together in a manner to form a spar embodying the maximum of strength with the minimum of weight.

LANDING AND LAUNCHING DEVICE.—J. F. CRANCE, 304 Madison Ave., Albany, N. Y. The invention relates to landing and launching devices for airplanes of the monoplane or biplane type. The primary object is to provide means whereby an air vehicle may be launched in a comparatively restricted area, the same advantages being gained in landing the vehicle, when the device will act more or less as a brake or retarder.

Electrical Devices

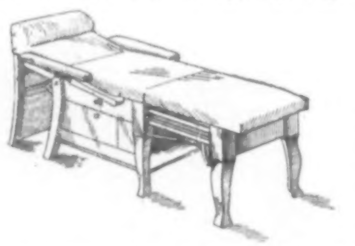
FAN BLADE.—A. W. TUCKER, c/o Hotel Tulsa, Tulsa, Okla. The invention relates more particularly to a ceiling fan blade. The principal object is the provision of a blade which may be swung from a horizontal to a vertical position. A further object is to provide a form of hinge with means for vertically adjusting the angle of the fan blade and holding it in its adjusted position.

Of Interest to Farmers

FARM GATE.—G. E. HARDESTY, Folsom, N. M. An important object of the invention is a farm gate in which the gate proper will be in all of its operative movements positively braced and constrained to travel in the proper path, thereby preventing distortion or excessive strain upon the gate or any of the associated parts. Another object is to provide a post construction co-operating with the free end of the gate which will insure automatic locking of the gate in closed position.

Of General Interest

COMBINATION CHAIR AND BED.—S. and I. SPECTOR, 503 Ashford St., Brooklyn, N. Y. The invention relates particularly to a chair which may serve as a bed. An object is to provide a chair which is especially adapted



A PERSPECTIVE VIEW OF THE CHAIR AS A BED

for use by invalids, and which can be readily converted into a bed by a simple operation, the back of the chair being hingedly connected so that it may be lowered, and the underbody of the seat portion extending to support an upper cushion hingedly connected with the seat of the chair.

MUCILAGE TUBE.—M. MACHLES, c/o Geo. J. Gruenberg, 320 Broadway, New York, N. Y. This invention pertains more particularly to a device constructed to contain mucilage and facilitate its application. An object is to so construct the device that it will readily stand upon one of its ends when not in use without affecting the discharge of the contents, and will permit of regulating the discharge of the mucilage.

LAWN SWING.—G. H. BUGENHAGEN, New Jacobson Bldg., Minot, N. D. An object of the invention is to provide a swing of the type described in which the swinging portion is suspended directly from supporting legs in such manner as to permit the occupant or operator of the swing to pass between the legs, or to be used in a modified form in which the swinging portion may be suspended from a porch ceiling.

CLOSING DEVICE FOR RUBBER TUBING.—E. O'CONNOR, 48 Ridgewood Ave., Newark, N. J. The object of the invention is to provide a closing device for rubber tubing such as is used for douche bags, fountain syringes and like devices, and arranged to permit the user to conveniently manipulate the closing device when in position on the tube and to insure effective closing and opening thereof.

MILK BOTTLE HOLDER.—M. A. PASCALE, 199 W. 10th St., New York, N. Y. An object of the invention is to provide a milk bottle holder which is adapted to be secured to a door or other support, which will readily admit the bottle and which when the bottle is in the holder will operate to securely lock the holder in its closed formation and prevent removal of the bottle by unauthorized persons.

SHUTTLE CLAMP.—L. O. ROBERTS, 146½ Killingsworth Ave., Portland, Ore. The invention has for its object to provide means by which a shuttle may be firmly gripped and held during the winding of the thread. The device comprises a clamp of substantially U-shape, consisting of a body and arms extending at its free end and on its inner face a transversely extending groove for engagement by the edge of a shuttle face.

Hardware and Tools

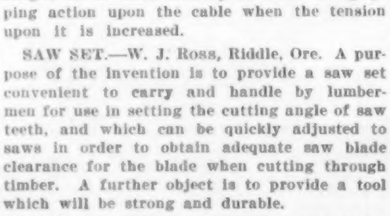
VALVE AND GRINDING MECHANISM THEREFOR.—H. C. BROWN, 854 Haddon Ave., Camden, N. J. An object of this invention is to so construct a puppet valve as to permit the positive longitudinal movement of the

AN ELEVATION AND CROSS SECTION.

valve as well as the rotary movement during the grinding operation. A further object is to so construct the valve that the valve grinding tool will couple therewith and cause the valve to move longitudinally with the tool as well as receive its turning movement therefrom.

LOCK.—C. O. TRACY, Norwich, Conn. The invention has for an object to provide a construction in which a sliding hasp is used to connect the different parts of the lock mechanism. Another object is to provide a lock in which a sliding key is used on a pivotally mounted catch associated with a sliding bolt, the bolt being locked when slidingly moved into position and unlocked when the key is slidingly moved to a given position.

CABLE CLAMPING DEVICE.—J. H. SKOGMAN, 1514 Moffet Ave., Joplin, Mo. The invention relates to devices for temporarily connecting cables, or other flexible members to other members, a purpose being the provision of a clamping or connecting device



VIEW SHOWING TOP PLAN OF THE DEVICE.

which is simple in construction and which effectively clamps a cable thereto without injury, the parts of the device being so arranged as to automatically increase the gripping action upon the cable when the tension upon it is increased.

SAW SET.—W. J. ROSS, Riddle, Ore. A purpose of the invention is to provide a saw set convenient to carry and handle by lumbermen for use in setting the cutting angle of saw teeth, and which can be quickly adjusted to saws in order to obtain adequate saw blade clearance for the blade when cutting through timber. A further object is to provide a tool which will be strong and durable.

PIPE WRENCH.—G. CAZENAVE, 319 Michigan Ave., Detroit, Mich. This invention has for its object to provide a pipe wrench wherein a relatively fixed jaw is provided and a relatively movable jaw loosely slidable on the fixed jaw, and a handle lever having a support adjustably connected with the fixed jaw, the handle having a cam for engaging the movable jaw to move it toward the fixed jaw.

Heating and Lighting

HEATING STOVE OR FURNACE.—F. D. COOK, address Sam W. Miller, 1st National Bank Bldg., Blairsville, Pa. The prime object of the invention is to so combine sheet metal and cast metal as to overcome or minimize the defects of these metals as used in the usual ways for producing a stove. The invention includes a cast metal base, a cast metal fire pot thereon and a sheet metal shell being open at its lower end, and fitting snugly about the fire pot.

HEATER AND VENTILATOR.—J. A. GREENE, Long Beach Sanitarium, Long Beach, Cal. This invention has for its object to provide a device adapted for comfortably heating a room with any type of heater wherein the fresh air that is distributed to the room is heated in a heating chamber separated from the combustion chamber, the heating and combustion chambers having separate and independent circulations.

FRONT DISCHARGE CHAMBER OF MELTING FURNACES.—P. DHE, 42 Rue Notre Dame des Champs, Paris, France. The invention relates to an arrangement of front discharge chamber applicable to melting furnaces for the melting of materials such as metal, glass, volcanic rock and fusible clay. According to the invention the discharge chamber is divided into two compartments in communication with each other at their lower part, the first of said compartments receiving the melted material which issues from the melting furnace, while the second receives the decanted material and has a tap hole placed at suitable level.

DAMPER.—J. TANDY, 109½ S. Idaho Alley, Butte, Mont. This invention has for its object to provide a device adapted for use in fireplaces to control the draft, wherein a frame is provided of a size to register with the opening of the flue, and shaped to conform with the proper arrangement at the junction of the fireplace and the flue and having a damper capable of being operated from outside the flue for regulating the draft.

Machines and Mechanical Devices

APPARATUS FOR AND METHOD OF PREPARING VEGETABLES AND FRUIT.—N. ROSENFELD, 486 Shepherd Ave., Brooklyn, N. Y. The invention pertains more particularly to a machine for cutting vegetables and fruits previous to the cooking operation. The prime object is to provide a machine by which certain portions of a potato or similar food product may be cut throughout a portion of its body to permit of the access of the material in which the article is subsequently cooked.

BOTTLE WASHER.—E. W. DANA, c/o The Dana Co., Platteville, Wis. The invention relates to bottle washing machines especially adapted for use by dairymen who have a relatively small number of bottles to wash. A special object is the provision of a double brush spindle machine in which the spindles are movable toward and from each other, and which may be hand or power driven, there being means for throwing the friction wheels into and out of operative position.

FRUIT PITTING MACHINE.—A. V. JENNINGS, 708 St. Nicholas Ave. New York, N. Y. The object of the invention is to provide a fruit pitting machine for quickly separating the meat from the pits of cherries, peaches, olives and other hard stone fruits. Another object is to accommodate different sizes of fruits undergoing pitting at the same time, and to separately discharge the meat and the stones from the machine.

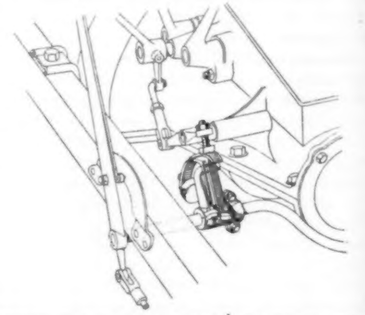
Railways and Their Accessories

BRIDGE WARNING.—W. STRIMPLE, 40 Astor Pl., Jersey City, N. J. The invention relates to bridge warnings and has reference more particularly to a warning consisting of a plurality of rigid suspended members positioned above a railroad track. Among the objects is to provide bridge warning members which are rigid so that they may not be bent or twisted out of shape, and which will not absorb water and freeze in the winter time.

LEAD CONTROL FOR VALVE GEARS.—C. T. HARDMAN, 2000 Johnston Ave., Nashville, Tenn. The invention relates to valve gears for locomotive engines. The foremost obpect is to provide an automatic lead control adapted more particularly for use with the Walschaert valve gear, the purpose being to automatically increase the lead of the steam valve as the engine speed increases, and when the reverse lever is hooked up for high speed.

Pertaining to Vehicles

SAFETY DEVICE FOR THE CLUTCH-CONTROLLING MEANS OF AUTOMOBILES.—J. CALCATERRA, c/o R. J. Cruice, 141 E. 23rd St., New York, N. Y. Two patents have been issued to this inventor on controlling and safety device which insure the natural position of the clutch of planetary transmission gears, particularly for Ford cars, and without modification of the original construction. The safety device is swung to set position with the movement of the controller shaft to apply the brake, to be engagable by a screw rocking with the clutch lever, but the Calcaterra device permits the release of the brake without releasing the safety device, the idea being to prevent the accidental running away of a car, when the brake is released, thus eliminating much emergency brake trouble by holding the clutch neutral until it is purposely thrown



PERSPECTIVE VIEW OF AUTOMOBILE WITH INVENTION APPLIED

into low gear position by depression of the pedal lever, whereby the safety device is automatically restored ready to be again operated when the brake is applied. Also it permits the car to be manually moved without being opposed by the brake. Stop means holding the device always in position to be operated.

MUD SHOE.—G. M. GLENN, 209 S. Glen St., Wichita, Kans. This invention relates to mud shoes or treads adapted to be applied to a tire of an automobile for extricating themselves from mud holes, sand mires, and similar places. An object is the provision of a mud shoe of simple construction, which can be quickly applied, and which provides gripping means on the tread surface and sides of the tire to effect a positive traction grip.

AUTOMATIC STEERING DEVICE.—H. DINGMAN, address Herminghauser & Herminghauser, Fort Madison, Iowa. The invention aims to provide a device, more particularly for use in connection with tractors, for drawing farm machinery, which may be integral with the front axle, or a supplemental axle to be attached to the steering axle, so that the same will work parallel to its last path of travel without the control of an operator, whereby he is relieved of all but the minimum of attention and may be in a position to adjust the plows or other devices.

Designs

DESIGN FOR A BRASSIERE.—H. FRIELAND, 53 Bank St., Newark, N. J.

Annual Subscription Rates
Scientific American Publications

Scientific American (established 1845) one year $6.00
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The combined subscription rates and rates to foreign countries, including Canada, will be furnished upon application.
Remit by postal or express money order, bank draft or check.

The New Concepts of Time and Space

(*Continued from page 155*)

the matter increases; and that every particle of matter that is not interfered with travels through space-time in the most direct path possible *in that continuum;* then the observed facts of gravitation are accounted for as an inherent geometric property of this space-time world. We usually say that the presence of matter distorts this world, and that this distortion gives the track of particles through the region affected its non-uniform character.

Gravitation then is not a force at all; it is the fundamental nature of things. A body free to move through the world must follow some definite path. Euclid says it will stand still; Newton that it will traverse a straight line in three-space at uniform time-rate; Einstein that it will move in a "geodesic" through time-space—in every-day language, that it will fall.

The numerical consequences of Einstein's theory are, within the limits of observation, the same as those of Newton's for all bodies save one—Mercury. This planet shows a small deviation from the path predicted by Newton's law; Einstein's theory gives its motion exactly. Again, when modern research showed that light must be affected by gravitation, Einstein's theory, because of the extreme velocity of light, deviates from Newton's, where the speed is less a determining factor; and observations of starlight deflected by the sun during the eclipse were in much better accord with Einstein's theory than Newton's. Moreover, the Special Theory predicts that mass is an observational variable like length and duration. Radioactive emanations have a velocity high enough to give appreciable results here, and the prediction is verified, tending to support the general theory by supporting its limiting case.

We like always to unify our science; and seldom, after effecting a unification, are we forced to give it up. Einstein for the first time brings mechanical, electromagnetic and gravitational phenomena within one structure. This is one reason why physicists are so open minded toward his theory—they want it to be true.

The Layman's Last Doubt

The final answer to any series of questions is inevitably "because the world is so constructed." The things we are content to leave on that basis are those to which we are accustomed, and which we therefore think we understand; those for which this explanation leaves us unsatisfied are those which are new and unfamiliar. Newton told us that the world of three-dimensional space with one-dimensional time superposed was so constructed that bodies left to themselves would go on forever in a straight line at constant speed. We think we understand this, but our understanding consists merely of the unspoken query, "Why, of course; what is there to prevent?" The Greeks, an intelligent people, looked at this differently; they would have met Newton with the unanimous demand "Why so; what is there to keep them going?" So if, in seeking an explanation of anything, we come sooner than we had expected to the finality "Because the world is so constructed," let us not feel that we have been cheated.

Film Lighting as a Fine Art

(*Continued from page 148*)

on that individual during the action. A veritable jumble of different intensities of light would result.

"The Sun Arc," a more powerful light than either the Klieg or the spotlight, is used for lighting up large settings, and also for producing moonlight or sunlight effects through windows. These lights are generally not focused right on the scene, but are centered on interposed diffusing or reflecting mediums, which, in

turn, reflect the light, diffused and softened, on to the scene itself.

The carbon arc and the mercury lamps are used in practically all illumination of any nature whatsoever, in film production. The kerosene or coal-oil flame will either not register at all, or will photograph black, under the stronger lights. So when an oil lamp, as used in settings of old-fashioned homes or country dwellings, where electricity is supposedly not available, is required in a scene, although the lamp has every outward appearance of an old-fashioned oil lamp, the flame within the shade is produced by a baby carbon arc.

A very common scene in which electrical illumination is always used but rarely ever suspected, is the one in which a leading player in the dark or in a dimly lighted room, lights a match and holds it up, cupped in his hands, to light a cigarette. As he does this there is a glow over his entire face and a very novel lighting effect is obtained. This glow is produced not by a match, but by a "baby" carbon arc which the player holds in his hands and which is connected up by means of wires which run down through his sleeve and connect with a switch outside the scene.

In scenes where flashlights are used, as in burglary scenes, the flashlight is equipped with a "baby" carbon arc, as the ordinary incandescent bulb in the head of the flashlight would not be of sufficient strength to register clearly.

When a fireplace with a burning fire therein is shown in a scene, it is not the flames, as is perhaps generally supposed, which makes the fire bright and cheerful. The fire itself would look dull were it not for the fact that there is a carbon arc underneath the rear of the hearth, out of sight of the camera, which throws its light through the gas flames and illuminates them.

When table or stand lamps are used in a setting, apparently to light up the scene, they are generally equipped with an automatic "baby" arc. There is a device by which three distinct degrees of current can be passed through the wires, thus making the light first dim, then bright, then very bright. When a player pulls a tiny chain in the lamp, supposedly extinguishing one bulb, the light goes dimmer. Then if he pulls another chain, supposedly extinguishing another bulb, the current is again changed and the light becomes very dim. This is arranged by means of signals from director to electrician. It is the general supposition of the audience that there are three bulbs in the lamp, and that these are extinguished one at a time by the player; whereas, in reality, there is only one light —the automatic "baby" arc—and this is dimmed or brightened by a control of the current by the electrician.

We now have under development a device whereby we will be able to cut the intensity of a spotlight or Klieglight from full light down to zero, or raise the intensity from zero to full light without changing the spread of the beam. This will make possible a fade-out or a fade-in with the lights and will provide many more novel and beautiful lighting effects in motion picture photography.

I confidently believe, however, that in the course of a few years the present system of motion picture lighting will be replaced by a system of illumination by incandescent lamps. The only light ray of photographic value is what is known as the actinic ray—the blue, violet and ultra-violet end of the spectrum. So far the carbon arc and the mercury arc are the best illuminants for producing this actinic ray, but experiments have already proven that the ray can be successfully produced with a new incandescent lamp which is still under development. When this is adopted, motion picture players will no longer suffer such eye afflictions as "Kliegeyes," a common malady that comes from working under the glaring lights of the present system. "Kliegeyes" is not caused, as is commonly supposed, by the carbon dust which is a product of the heated arc. On the other hand, this eye trouble is due to the actinic ray. The pupil of the eye regulates, by enlarging or diminishing in size, the amount of light which enters the eye. The pupil cannot close down sufficiently to keep out this strong, actinic ray, and the result is an inflammation of the nerve system of the eye. In acting, the player naturally opens his eye wide to "get over" certain expressions. This lets in more light. The electrician, who stands directly behind the light and gets more carbon dust than anyone, rarely ever has Kliegeyes.

Directors sometimes make the mistake of burning all their lights while rehearsing the players. This strain is too great on the eyes, as the rehearsals sometimes continue for a good length of time. To prevent "Kliegeyes," the director should first get his lights all set, and while rehearsing, burn one Klieglight—just enough to light up the set sufficiently to enable the players to work. Then, when the action is all ready to be photographed the lights should be turned on. In the short space of time while the camera is in action the strain will not be sufficient for any player to get "Kliegeyes" unless his or her eyes are unusually weak or inflamed.

The cost of lighting scenes varies according to the size of the set and the consequent number of lights used. For unusually large settings, requiring a great deal of light, the cost might range from twelve to fifteen dollars an hour for the lights.

Of course, the motion picture industry is still comparatively new, and we are still in the experimental stage so far as lighting goes. Not only in the studios, but in the movie theaters there is considerable room for improvement. A spectator entering the largest of our cinema palaces is generally plunged from bright daylight into murky darkness; he passes through the reverse experience when he leaves the theater. The eyes suffer a consequent strain, as the pupil does not have time to adjust itself to the sudden change. The author has been working for a long time upon a lighting system for theaters that would eliminate this. He recently installed this system in one of the leading picture houses here in Los Angeles, and the results are reported to be highly satisfactory.

When a person enters the theater, under this new lighting system, he enters first the lobby, which is a shade darker than the daylight outside. The pupil quickly adjusts itself to this gradual change. Then he passes into the foyer, which is a little darker still, and by the time he has reached his seat in the theater, his eyes are accustomed to the dim light. The light is carefully graduated, and the eyes have suffered no strain. They can see the screen perfectly.

The Army School for Weather Observers

(Continued from page 149)

the parapets to show if the wind came from the enemy's direction. If it did, it brought the danger of gas, and therefore gas was expected. Most of the effect of gas depended upon the element of surprise, so the little arrows helped win the war. Each regimental intelligence officer was charged with the duty of sending to the rear a daily report on the weather, especially the wind, for the gas people's information.

For the high altitude observations, a balloon filled with hydrogen, and two feet in diameter, is released and its angle of ascension, its drift and direction, are carefully observed, timed and recorded. These observations are made through a surveyor's transit, set up with the greatest exactitude over a fixed point and delicately oriented on a true northerly point.

Salt from the Sea

(*Continued from page 150*)

vested profitably from the sea at all times. It is not possible to utilize gravity to fill and empty all of the numerous ponds, and many of the bay plants have installed a great number of small wind mills which pump the water from one pond to another. Usually this pumping serves to get the water into the highest ponds, from which gravity will convey it through the intermediate ponds into the crystallizing tanks. Since strong trade winds blow regularly during most of the summer months at San Francisco, these wind mills supply ample power for pumping, although electric motors or gasline engines are used for emergency power.

Harvesting takes place from the crystallizing ponds, and the salt deposits are shoveled into wheelbarrows or tram cars and conveyed to the drying piles. The larger plants have small railroads, with electric engines to pull the trains of salt cars, but most of the smaller plants harvest by hand. The salt is not taken from the bottom of the pond, since the floor is usually made of mud, and this lower strata is left until the end of the season, when it is harvested separately and used for stock or in the manufacture of ice cream.

The salt when harvested is of a pinkish hue and still has considerable of the mother liquid remaining, and it is piled in huge pyramids or stacks to dry out before being milled. When made into small piles the crust sometimes becomes so hard that it is necessary to use a cross-cut saw to break it up into chunks. When made into larger piles, it is more easily handled. Bucket elevators, endless belts and other mechanical conveyors are used to transport the salt to and from the storage piles.

Crude sea salt contains considerable adhering pickle or bittern and dirt of various kinds, and washing is accomplished in various ways. The salt may be dumped into a hopper and flushed with hot brine, or it is sometimes sprayed with cold ocean water taken from the bay. Usually the brine employed in the washing process is concentrated to complete saturation so that very little salt is dissolved in the washing. After this first washing, the salt passes between rolls which crush it into "half-ground salt," and "three-quarters ground salt." It then goes to vats filled with artificial brine made from fresh water and salt, and consequently containing no mother liquid salts. When washed in this solution the salt is stacked in heaps to drain. If intended for the coarser uses of trade the salt is sacked in its present condition, but if intended for further refining the salt goes to vats which lead to centrifugal machines by which all adhering water is removed. It is then conveyed to driers, made up of long revolving cylinders containing steam coils and provided with fans that pump warm air through. When dried, the salt is passed through heavy rollers which crush it into granular or powder form, and it is then sifted and graded for fineness, when it is ready for packing.

The amount of salt harvested from sea water averages from four to six inches in the crystallizing ponds, and at many of the plants two or more harvests can be secured each season. California produces about a million and a half barrels of sea salt per annum, which is sold throughout the Pacific Coast and to some extent in the Eastern States. In the interior of the State are vast deposits of salines containing a number of valuable products, including common salt, and some of these deposits are being worked for their borax, potash and other contents.

Solid Fuel for the Gas Engine

(*Continued from page 151*)

which is thus at all times instantly supplied with the exact amount of moisture necessary to meet the demands of the instant.

This producer is designed by Mr. A. L. Galusha of New York, and represents the fruit of many years' specialization in this field. In regular service it has shown an economic efficiency as high as 87 per cent, at full load; under average conditions it will not fall far short of delivering that proportion of the actual heat units in the fuel, in a clean, rich, cool gas of uniform quality. The average coal available for use in the producer contains 12,500 British thermal units per pound; this producer will deliver easily 10,000 of these in the gas. The modern gas engine will deliver at full load one brake horsepower on this fuel value; the net result is then a fuel consumption of but one pound of coal per brake-horsepower-hour.

Another feature of the new producer that is usually questioned by prospective purchasers, and that only receives full credit after long use has demonstrated it, is the ability of the apparatus to go right on delivering its full rated capacity while the ash-pit is open for cleaning. For those who are not acquainted with the merits or demerits of the ordinary producer it may not be out of place to state that there is no smoke and no chimney. The space required is less than that necessary for a steam plant. Allowing for economical intermittent service, the claim is made that the stand-by loss is a bare one-seventh that suffered in the use of steam. A very notable point is that the range of fuel is almost limitless. The use of a fairly decent grade of coal is of course recommended; but the manufacturers of the producer are most enthusiastic in their statements that anything that will burn, and some things that won't burn, may be used in the producer to generate gas. Clean water is not at all necessary, since steam is not used in working parts but is merely supplied as an ingredient of the gas.

This producer is designed to replace the steam engine in the ordinary power plant of moderate or moderately large capacity. The makers of the engine used during the war in our submarine chasers are operating their factory with a producer, at a coal economy of seventy per cent, the producer supplying gas to one of the company's own engines. A prominent maker of natural-gas engines for stationary use is installing the producer as standard equipment and finds it cheaper than the natural gas. In pottery kilns, in supplying both heat and power in a chemical plant, and in ice plants the producer is in satisfactory service. In the latter instance, a production of ten tons of ice per ton of coal burned under boilers has been replaced by a production of thirty tons per ton of coal burned in the producer. This particular producer is eminently suitable for marine use, and it was in a vessel just arrived from the other side that we first saw it in operation. It is also in wide use in municipal power plants in small and medium-sized towns and cities.

Modern engineering skill often brings about a situation where what appears to the layman to be a roundabout procedure is the most efficient and the cheapest. There can be little doubt that the producer is a case in point. Within very wide limits the statement is a safe one, that a given amount of coal converted into gas in this producer and used in an internal-combustion engine will yield a much greater return in power, at lower cost of operation and lower initial cost of installation, and with increased reliability of operation, than if it were employed under a boiler to convert water into steam for direct application.

Keeping Check on Factory Air

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from the alkalinity which disappears, that definitely absorbed by the carbonic acid.

In order to find the carbon monoxide with this apparatus, use is made of the

method of Professor Armand Gautier, based upon the reduction of iodic acid. In this case, he attaches, beyond the ground opening of one of the washing bottles, an elbow-shaped glass manifold containing iodic acid which is electrically heated to around 100 degrees by means of a little storage battery. Another washing bottle is also connected to the free ground end of the manifold. Lastly, in the two receptacles five cubic centimeters of water of barium is poured. The air aspired gets rid, first of the carbonic acid, which is analyzed later; and it passes then through the iodic acid in which the formation of a dimness of a precipitate denotes the presence of carbon monoxide. The final operation is the analysis of the carbonate formed and the ascertaining of the quantity of iodine fixed by the barium, which is used as a means of control.

Lastly, the presence or absence of most of the other possible impurities can be ascertained with the help of a mixture of solution of silver nitrate and permanganate of potassium. After two liters of air passes through the bottles, the liquid must remain pink in color.

With this apparatus, Dr. Kohn-Abrest has combined a very small-sized laboratory for the analysis of industrial toxicology, and by means of which it is possible to make easily on the spot most of the chemical experiments of hygienists. These sets contain bottles, re-agents, vials, spectroscopes, vats and other instruments, which are placed in easily transported oak cabinets and simplify greatly the equipment necessary for making current analyses. Naturally, analyses made quickly with this instrument do not supersede completely the making of complementary verifications and researches which the experts of the laboratory should carry out with more precise scientific apparatus, such, as for example, the Ogier mercury counter for fire-damp. With this last apparatus, the combustion of the gases to be analyzed in air, is obtained in a glass vessel at constant temperature crossed by a platinum coil heated to incandescence by electric current. The sensitiveness of this counter for fire-damp varies between 1/2000 to 1/6000, according to the nature of the other noxious gases present.

Why Not Radio?

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for a greater commercial radio service.

Eleven miles southwest of Bordeaux, France, is the most powerful radio station extant. Known as the Lafayette station, it was constructed by our Navy during the war for the purpose of maintaining communication with our forces in Europe, even in the event of a complete severance of cable communication. The armistice found us with the Lafayette station partly completed, and it was decided to finish the work and sell the station to the French Government as another item of our salvaging operations.

The Lafayette radio station has been in commercial operation for some time, and the accompanying illustrations furnish some idea of its magnitude and excellent construction. The aerial of this huge station is supported by eight steel towers, each 820 feet in height, arranged in two rows of four each, the rows being spaced 1,320 feet apart. In all, the aerial system covers a plot a mile long and a quarter of a mile wide, or something like 5,227,200 square feet. The arc transmitter is rated at 1,200 kilowatts, and of this something like 500 kilowatts is delivered into the antenna. The range is said to be 12,500 miles under favorable conditions, or half-way 'round the world.

As in the instance of several other high-power stations, the Lafayette station may be operated at a distance. In fact, the business office for the station is Bordeaux, and the operators control the station by land lines. In the near future the Lafayette transmitter will probably be operated from Paris in order to offer more direct service to French traffic. As compared to the Brest-New York cable, which has a capacity of about 25 words per minute, the Lafayette radio station has a capacity of 50 words and over per minute.

The Lafayette station is not destined to remain the largest radio station for very long. Already, work is well under way on what is to be known as the New York Central Station, on Long Island, near Port Jefferson, a short distance away from New York City. The new station will cover 6,400 acres of land. It will have five complete transmitters, each one a duplex unit with a corresponding receiving station located near by. All five transmitters and receivers will operate simultaneously.

The aerial layout is decidedly a new departure. From the central power house six spans of aerial wire will radiate out in a star pattern to a distance of more than one mile from the center. The wires will be supported by steel masts, each 400 feet high. Each of the six antennæ will have twelve towers, or seventy-two towers in all. Five of the antennæ will be used for regular service, while the sixth will be held in reserve. Each transmitting antenna is to be charged by two 200-kilowatt Alexanderson high-frequency alternators. The receiving units will be located eighteen miles away.

Then there is the Sainte Assise station now under construction near Paris. So gigantic is this station that one begins to wonder whether the French intend to maintain their present radio supremacy for all time. Otherwise conservative, the French people are going to the very limit in the matter of high-power radio stations.

The Sainte Assise station is located about 25 miles outside of Paris. When in operation, it will have a capacity of 2,000,000 words every twenty-four hours, for two-way traffic. The aerial system will comprise over 130 miles of wire, and will cover some 750 acres of land. This wire network will be supported by sixteen towers of about 800 feet in height. The towers will be arranged in two rows of eight each, set 1,800 feet apart and extending over two miles in length.

It is understood that the unit transmitter system, as already described for the New York Central Station, will be employed in this French station. That is to say, there will be three high-frequency alternators of 500-kilowatt capacity, each being used separately to charge a separate section of the antenna, or the three can be used together for the full power. It is also understood that there will be a separate installation, with a single 800-foot tower, for handling messages over limited distances, particularly for nearby European countries. The receiving stations, numbering from five to seven, will be located some distance away.

The Motor Truck and the Shoe Factory

(*Continued from page 154*)

sary constant transfer of goods between the plants.

Until a little more than a year ago the company had all its hauling done by rail, then the traffic manager decided that trucks could do the work more economically and give better service. Three 5-ton trucks and one 2-ton truck were put into service in November, 1918. The work these trucks accomplished in a year is decidedly interesting. An executive of the company says:

"Over the 11-month period the trucks have hauled more than 11,000 tons of materials to and from Boston, at about one-half the cost of former methods, and they have improved service by about 100 per cent. When we sent out products by rail we usually got deliveries on the day after they were shipped from Brockton to Boston. With trucks we get out loads to Boston and our materials back from the factories the same day they are shipped. At a time when leather was very scarce, our buyer was hard at work picking up such small quantities as he could and sending them to Boston; and with our trucks we rushed the leather to the factories, where the need was great, on the same day it reached Boston. By rail, this would have taken a day longer. Goods for the North Adams plant are sent by trucks to Boston and then direct by rail saving a day en route.

"To haul our diversified loads, our truck bodies are built with rack sides and rear to a height of six feet. This accommodates the many cases of shoes that a truck can haul without being overloaded. One day recently one of our trucks hauled 1,000 cases of shoes, besides our regular daily shipments, to Boston for reshipment to Italy. Our 2-ton truck runs 70 miles a day between Boston and Brockton, stopping on each trip at the East Weymouth factory. Recently this truck made the 160-mile trip to North Adams in 10 hours, with capacity load much of the way over steep grades. Our trucks have been invaluable to us. They operate economically and they are very durable. They get there—and when factories are waiting for materials it is reliability that counts."

A New Wheatstone Bridge

A NEW Wheatstone bridge has been devised what it is said will do away with the inaccuracies of the usual bridge is that there are no change-over switches in the new one. It retained the advantage of multiple comparative resistances and is claimed to be simpler and cheaper than the key type. It is of German origin and is described briefly as follows:

The principle is the provision of several bridge circuits, each fitted with a button, while each of the comparative resistances is connected on one side with a terminal and fixed on the other to the measuring wire end. There are thus no loose connections or movable contacts, so that the original accuracy is not affected by dirt or rough handling. As each resistance is independent, the bridge circuit is divided into three subcircuits, each with a button contact to switch-in the battery. A lead runs from the point of junction of the three bridge circuits to the right-hand battery terminal, and a lead runs from the slider contact through a 5 ohm regulating resistance to the left battery terminal. The current source thus lies between the bridge circuit junction point and the slider contact. Battery or galvanometer can, of course, be used as required. All other connections are as in the ordinary Wheatstone bridge. A further advantage of this instrument is that it is possible to have a measurement range with as low a resistance as 0.01 ohm.

New Process for Cracking Oils

A NEW process, details of which are being withheld from the public at present, has been evolved by the division of Engineering Technology of the United States Bureau of Mines for the cracking of heavy oils. The newly-discovered method augmented by special apparatus will reider useful bulky petroleum and tars now considered unprofitable to recover as oil because of the difficulty in conveying through pipe lines or to use as fuel because of their high viscosities.

The scientific discovery as made by the Federal Government involves the cracking of these heavy oils and tars into lighter products, thereby extracting therefrom a considerable volume of gasoline and low-viscosity fuel oil. The obstacles heretofore encountered by the formation of carbon and tars, according to claims, have been surmounted, and tests of the processes on a commercial scale are recommended. If operations of magnitude are successful, the production of gasoline from the heavy oils and residuums gushing from the wells in California, Mexico, Texas, and elsewhere, will be possible.


INTER-CITY HAULING